Vol. XXIII, No. 3
APRIL 1956

THE SCIENCE TEACHER

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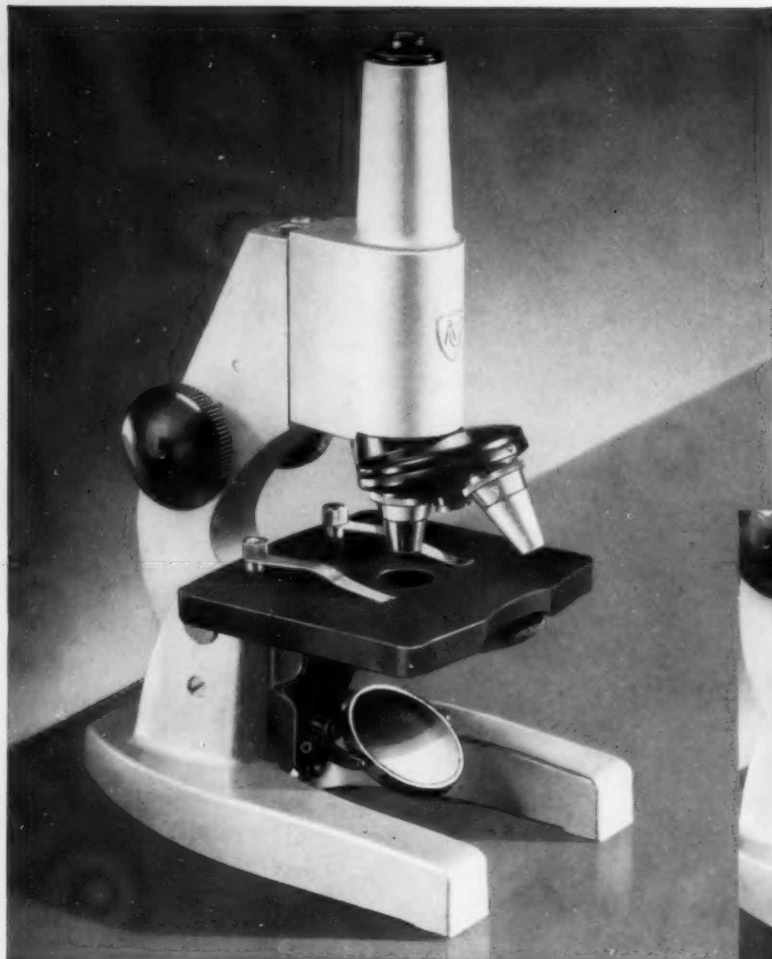
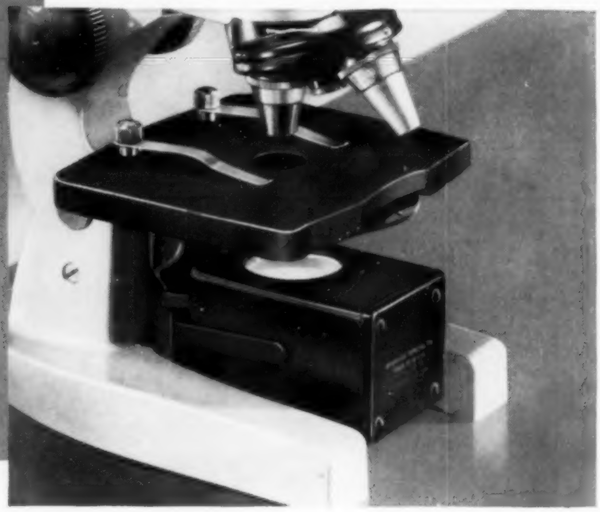
- Laboratory Exercises for the Life Sciences
- Making Photographic Prints in the Classroom

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION





U. S. ARMY PHOTOGRAPH

THIS MONTH'S COVER . . . Taylor Elementary School, Arlington, Virginia, March 15, 1956. Three students show examples of their pottery work to Capt. Emory W. Kline, The Engineer School, U. S. Army, Fort Belvoir, Virginia. Capt. Kline was one of 1200 scientists and engineers who took the place of science teachers in public, private, and parochial schools in Washington and surrounding counties so that they could attend the Fourth National Convention of the Association. The program in this area was operated by the Joint Board on Science Education for the Greater Washington Area. We were gratified to hear that science teachers in many other parts of the country found a scientist for their classroom, as well as full or partial expenses so that their trip to Washington could be a reality.

Readers' Column

March 15, 1956

Mr. Robert H. Carleton, Executive Secretary
National Science Teachers Association
1201 Sixteenth Street, N. W.
Washington 6, D. C.

Dear Mr. Carleton:

The program of Science Teacher Achievement Recognition (STAR Awards) which is being conducted by the National Science Teachers Association in cooperation with the National Cancer Institute will produce excellent results, I am sure, for the general improvement of science teaching at the pre-college levels through recognition of superior science instruction in the schools.

In anticipation of the renewed and enlarged interest in science courses which this program will undoubtedly stimulate, I should like to suggest that NSTA members, and all teachers of science courses, be reminded of the necessity of observing strict rules of humane treatment of animals used in laboratory experiments. I would especially recommend that experiments involving animals be carried out only in the classroom or other appropriate place under the supervision of the teacher, and that students be discouraged from designing or conducting their own animal experiments at home or at other places without teacher supervision. Removal of animals from the school laboratory to the homes of students or other unauthorized places for any purpose whatsoever should be strictly forbidden.

In general, such rules as those enforced at the National Institutes of Health would be suitable, I should think, for any public, parochial, or private school. They provide that:

1. Animals shall be purchased from regular animal dealers only, and not from individuals.
2. Animals in the laboratory shall receive every consideration for their bodily comfort, shall be kindly treated, properly fed, and maintained under sanitary conditions.
3. No operations on animals shall be performed without proper authorization.
4. Operations shall be performed on animals only with aenesthetization as directed by professionally competent authority.
5. When sacrifice of the animal is necessary this shall be done painlessly. Animals kept alive to determine the results of an experiment shall receive, in so far as possible, the same care to minimize discomforts as that given a human being.

I hope you will agree that by following such rules as these both students and teachers will obtain better results in their science courses and that students will be better prepared to assume the responsibilities of laboratory management should their interest in science subjects lead them, as we hope, into careers in scientific research.

Sincerely yours,

JOHN R. HELLER, M. D.
Director
National Cancer Institute

It is good to be reminded of these "operating rules," although I am confident that such safeguards for animals used in school science study are widely practiced by science teachers. Teachers would be foremost in realizing that neglect, mistreatment, and suffering of experimental animals contribute negatively to the goals of science teaching; also, that the use of some animal experimenation in well-designed studies is almost essential to the attainment of certain goals.—*Editor.*

The services of the Association are greatly appreciated and of tremendous help to the teacher. The issues of *The Science Teacher* are becoming increasingly helpful with each new issue.

CHARLES CONWAY
St. Louis, Missouri

THE SCIENCE TEACHER

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Coming . . .

in the May issue of *The Science Teacher*

- The Philosophy of Test Construction in Science
- College Teachers Look at High School Science
- Is the Science Teacher Shortage a Curriculum Factor?
- 1956 Winners of Science Achievement Awards for Students

Editor's Column

We science teachers need to get the facts straight on three or four controversial issues. We need to know "whereof we speak." And then we have a duty to "speak up, in behalf of our profession"—and to help straighten out others who are sincerely concerned and want to help with the improvement and strengthening of science teaching.

It is probably far from true that "50 per cent of American high schools offer no courses in chemistry, and 53 per cent none in physics."

It is completely misleading to say that "only 4.3 per cent of them (high school students) study physics (today) as compared to 19 per cent at the turn of the century."

Who knows whether "familiarity with physics and chemistry in Soviet Russia begins as early as the sixth-grade" is not equalled, or exceeded, by the American program of elementary school science which begins in the *first grade* in thousands of schools?

It is indeed disturbing that such statements of doubtful validity have been used repeatedly in public speeches and newspaper columns in recent months. Sharing in the perpetuation of these questionable notions have been such leading figures as the Chairman of the Atomic Energy Commission (in his address to the 6th Thomas Alva Edison Foundation Institute), the Director of the National Science Foundation (in his address at the AAAS meeting in Atlanta last December), and such newspaper writers as Dorothy Thompson (in her syndicated column in the Washington *Evening Star*, February 27, 1956), Benjamin Fine (in various issues of *The New York Times*), and Ansel E. Talbert (in his column in the *New York Herald Tribune*, March 1, 1956).

I think I can identify the source of these misconceptions. The U. S. Office of Education *Bulletin No. 9*, 1950 reported (page 5) that of 623 schools responding in a sample survey of 1947-48 science enrollments and offerings, 47.8 per cent offered physics *that year* and 49.4 per cent offered chemistry *that year*. In the text on page 4 (which apparently few columnists and speech writers have taken time to read and think about), it is pointed out that: "More schools offer the regular science courses and more pupils enroll in them than was reported by the schools for this study. This is due to the fact that some schools make a practice of alternating science courses in successive years. . . . Data concerning the extent to which alternating of science courses is practiced in public high schools were not obtained in this study."

Also, it has been the custom in U. S. Office of Education reports to give percentage enrollments on the basis of the total four-year high school student population. Since physics is usually offered at the 12th grade, it is more than a little misleading to base the percentage of students in this course on the number of all students in grades 9, 10, 11, and 12. The same argument holds for chemistry, biology, and even general science—which, as all of us know, is taken by practically 100 per cent of the students, the equivalent of a year or more in grades 7, 8, and/or 9. Moreover, this kind of course designed to provide education in science for *all* students was not even in the curriculum in "the good old days" at the turn of the century.

(Please continue on page 148.)

THE SCIENCE TEACHER

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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

NUCLEAR ENERGY

By F. G. DUNNINGTON

Professor of Physics, Rutgers University, New Brunswick, New Jersey

"ATOMIC ENERGY" has been a much discussed topic for several years, a topic involved in news stories almost daily. What is presented here is designed to summarize some of the more important basic facts concerning this subject.

You will note that, in conformity with common usage, the adjective "atomic" has been used to describe the energy with which we are concerned. Actually, we are not talking about atomic but rather about *nuclear* energy. Atomic energy is something entirely different. Perhaps the clarification of this is a good place to start this discussion.

Let us consider two sources of energy: a *furnace* burning coal and a *nuclear reactor* (or "pile").

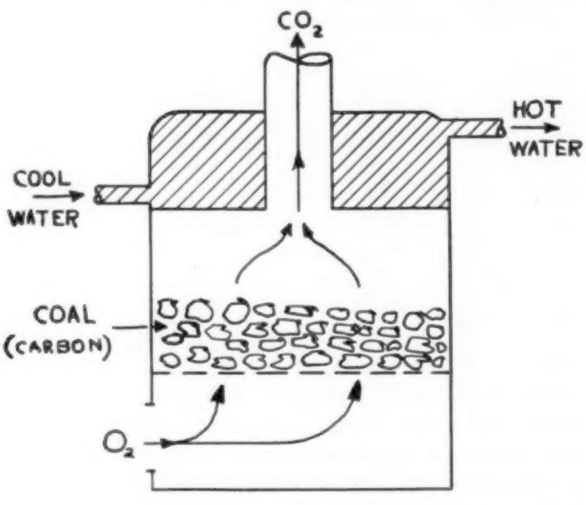

FIGURE 1. Furnace (hot-water type)

$C + O_2 \rightarrow CO_2 + Q(4.1\ ev)$

To be specific, let us consider a hot-water type furnace as shown in Fig. 1, and to reduce the complexity let us assume we burn coke instead of coal. Coke is essentially carbon, so that the "burning" process is represented by the following chemical reaction.

$$C + O_2 \rightarrow CO_2 + Q(4.1\ ev)$$

The burning of the carbon forms carbon dioxide gas and releases energy. The amount of energy released for each atom of carbon burned is about 4.1 electron volts. (The "electron volt" is a small unit of energy equal to the kinetic energy gained by an electron falling through a difference of potential of one volt.) What is the origin of this energy? An atom of C and a molecule of O_2, when combined into CO_2, have a reduced potential energy. This can be represented by the diagram given in Fig. 2.

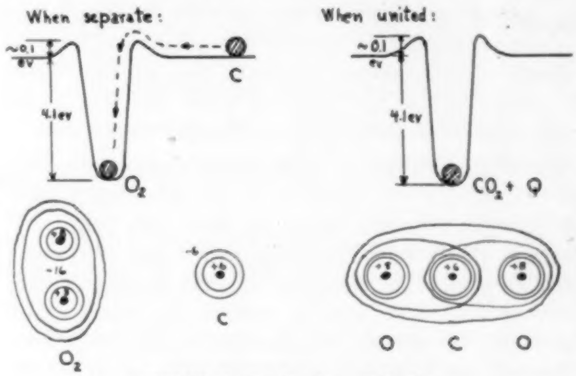

FIGURE 2. Combustion of Carbon

To bring the carbon atom and the oxygen molecule near enough together to unite, it is first necessary to overcome a repulsive force between them (repulsion of like, negative charges). Having passed this region at about 1.33×10^{-8} cm, the atoms are then *attracted* (+ charge of nucleus to — charge of electrons in adjacent atom) till they reach a separation of 1.15×10^{-8} cm, at which point these attractive forces are just balanced by repulsive forces between the nuclei (like, positive charges). During all this motion together, there has been a rearrangement of the valence electrons in that they

are shared between atoms. The reduction in potential energy of the atoms, namely 4.1 electron volts, appears as kinetic energy; that is, as heat.

It is important to note that in this, and in all other chemical reactions, the nuclei remain entirely separate. The energy of such a reaction is, strictly speaking, "atomic energy", for it is due to the relative position of the atoms. However, it is commonly called the *heat of formation,* or (for oxidization) the *heat of combustion.*

Now let us consider as a second source of energy, the nuclear reactor. There are many forms but the basic principle is the same. Let us consider the heavy-water type, as found, for example, at the Argonne National Laboratory. In very much simplified form this is represented in Fig. 3. The

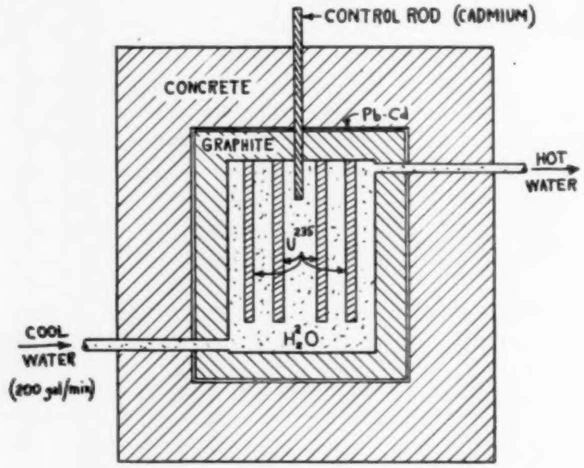

FIGURE 3. Nuclear Reactor (heavy-water type)

coke of our furnace is replaced by the rare isotope of uranium, U^{235}. This is in the form of 3 tons of natural uranium made up into 120 rods, 1.1 inch in diameter and 6 feet long; the U^{235} constitutes about 0.7 per cent of the uranium. To prevent corrosion and to confine the radioactive products, these rods are sheathed with aluminum. The rods are in a large aluminum tank about 6 feet in diameter and 9 feet high.

The oxygen necessary in our coke furnace has no exact equivalent in the reactor. Roughly its role is taken by neutrons. Surprisingly though, one does not have to supply the reactor with an external source of neutrons; rather the reactor supplies its own neutrons. To understand this we have to examine the reaction which takes place. This reaction is actually the "fission" of the uranium nucleus into two approximately equal parts. This may be represented as shown in Fig. 4. The splitting, or fission, of the unstable U^{236} nucleus can be visualized as a violently agitated drop of

$${}_{92}U^{235} + {}_0n^1 \rightarrow {}_{92}U^{236} \rightarrow {}_{46}Pd^{117} + {}_{46}Pd^{117} + {}_0n^1 + {}_0n^1 + Q$$
(200 Mev)

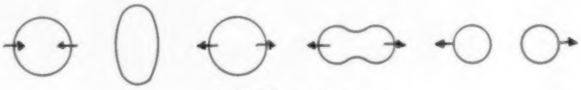

FIGURE 4. Fission

water which finally splits into two parts. This is over simplified; in the usual case two or three small fragments (neutrons) are also split off. These are the neutrons which in turn cause other fissions and maintain the process.

What causes the violent agitation of the U^{236} nucleus? The energy represented by this agitation comes from the loss of potential energy of the neutron when it is captured by the U^{235} nucleus. This energy is quite large, amounting to about 6.8 Mev (Mev = 1 million electron volts). This is, in fact, larger than the energy, about 6.6 Mev required to separate the U^{236} nucleus into approximately equal parts. Hence the U^{236} splits up; that is, the second reaction takes place and an energy of about 200 Mev is released.

These energy relationships can be visualized in the graphical pictures of Fig. 5. When separate

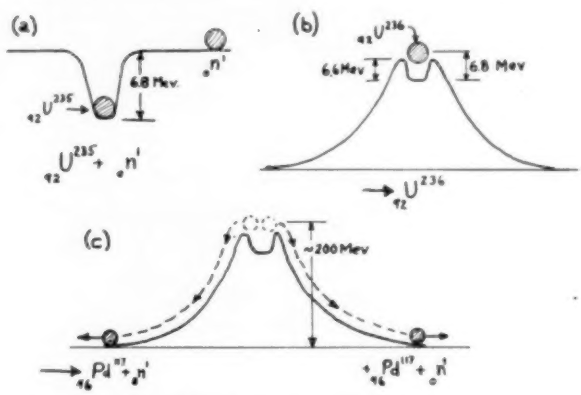

FIGURE 5. Fission Energies

(Fig. 5a) the neutron and the U^{235} nucleus have a potential energy of 6.8 Mev; when they come together and unite to form a U^{236} nucleus, the latter will then have an excess energy of 6.8 Mev. Fig. 5b indicates that the U^{236} nucleus can be split into two approximately equal parts with the expenditure of 6.6 Mev; further, if two approximately equal parts do begin to separate, they will be pushed apart by strong forces of repulsion (like + charges). For this reason the two sides of the potential plot are not horizontal but slope rapidly downward as shown. Since the U^{236} nucleus has more than enough energy to split apart, it does so as repre-

sented in Fig. 5c, and the two parts gain a total kinetic energy of about 200 Mev.

Thus in fission the parts of the *nucleus* have less potential energy when separated than when together (Fig. 5c). This is to be contrasted with usual chemical reaction of combustion in which the *atoms* have *greater* potential energy when separated than when combined (Fig. 2). Further, in fission the energy release is very great indeed compared with that in combustion. Let us compare the energies released per *unit* mass consumed (Fig. 6). The

$$\text{BURNING CARBON: } \frac{Q}{\text{Mass}} = \frac{4.1\ \text{ev}}{12_c + 32_{O_2}} = 0.093\ \text{ev/mass unit}$$

$$\text{FISSION OF } U^{235}\text{: } \frac{Q}{\text{Mass}} = \frac{200\ \text{Mev}}{235_U + 1_n} = 0.85\ \text{Mev/mass unit}$$

FIGURE 6. Energy Produced

fission of U^{235} yields about 9 million times the energy per pound of fuel used as compared with the combustion of carbon.

The fundamental difference between atomic and nuclear energy is now evident. Atomic energy, using the words in the strict sense, comes from chemical reactions (Fig. 2) in which the atoms as a whole take part and in which the electron clouds around the atoms are slightly distorted. The nuclei remain completely separate. Nuclear energy on the other hand comes from reactions (Figs. 4 and 5) in which two nuclei combine and (in fission) split apart into new and different nuclei. The electrons do not take part in the reaction and, in fact, do not even have to be present.

We have indicated that the nucleus splits into approximately equal parts on fission. Actually the division varies, with the masses most frequently occurring near the values 95, 139, and 2 neutrons instead of 117 and 2 neutrons. This does not appreciably alter the energy released.

Let us now finish the description of the heavy-water type of nuclear reactor. There is very little likelihood that fission of U^{235} will occur unless the neutrons that enter into the reaction are "thermal" neutrons, that is, have a kinetic energy of about 1/40 ev corresponding to room temperature. Unfortunately, the neutrons produced in the fission process have energies of several Mev. As a result they go right on through a nucleus of U^{235} and are not captured. To convert these fast neutrons to thermal neutrons, a "moderator" is employed; a moderator is any substance that will slow down the neutrons by repeated collisions to thermal energy, and do this with negligible absorption of the neutrons. In the Argonne reactor (Fig. 3) the moderator is "heavy water" which fills the remainder of the tank around the rods. Heavy water is simply water in which ordinary hydrogen of mass 1 has been replaced with "heavy" hydrogen, i.e. deuterium, of mass 2. Six and one-half tons are used in the Argonne reactor.

One very important feature of every reactor is a means of controlling the energy level. This appears in the form of control rods which contain material which absorbs neutrons readily. The Argonne reactor uses cadmium for this purpose. When inserted into the reactor, these absorb so many of the neutrons that the number of fissions per second drops to a low value. Conversely, if these control rods were withdrawn too far from the reactor, the number of neutrons and hence the number of fissions per second would continuously increase until the reactor melted or an explosion occurred.

Shielding to reduce the external radiation is a very important part of any reactor. In the Argonne reactor there is first two feet of neutron reflector of graphite, then four inches of a lead-cadmium alloy, and finally eight feet of concrete. All this reduces, but does not by any means eliminate, all the radiation.

The Argonne reactor has a 300-kw power rating. This energy appears in the form of heat and is removed from the reactor by pumping the heavy water through it at the rate of 200 gal./min. A larger reactor of similar construction at Chalk River, Canada, has a power rating of 10,000-kw.

Two other types of reactors will be mentioned. One, the graphite-pile, uses graphite in place of heavy water for the moderator. The other, called the "water boiler" or "homogeneous" reactor, uses a solution of a uranium salt dissolved in heavy water; this solution is thus both the fuel and the moderator.

The nuclear energy we have been discussing so far has come from fission, or the *splitting* apart of heavy nuclei. There is a different and newer source of nuclear energy—that of fusion, or the *combining* of light nuclei. This is the basis of the "hydrogen bomb."

The fact that some nuclei yield energy when split apart (fission) and others yield energy when combined (fusion) arises from the following: all nuclei are made up of protons and neutrons. The mass of every nucleus is *less* than the sum of the masses of protons and neutrons of which it is composed. The mass that disappears during the formation of a nucleus is replaced by an equivalent amount of energy. This is simply an example of Einstein's

famous relation, $E = mc^2$. The mass that has disappeared during the formation of a nucleus is a measure of the total loss in potential energy of the protons and neutrons that make up the nucleus; that is, it is a measure of the depth of the potential well that would be drawn for the particles in a given nucleus. This energy is referred to as the total binding energy.

Now the important point is this: the binding energy per nucleon (i.e., proton or neutron) is greatest for nuclei of mass about 70 mass units and is therefore less for both heavier and lighter nuclei. This can be seen on Fig. 7. As a consequence,

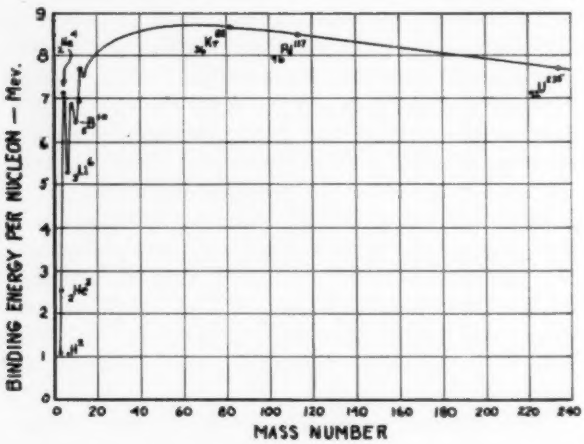

FIGURE 7. Binding Energy

energy is released when heavy nuclei split apart (fission) and also is released when light nuclei combine (fusion).

Consider the fusion of heavy hydrogen H^2 with the very rare hydrogen isotope tritium H^3. This fusion is indicated in Fig. 8. The energy released

HYDROGEN BOMB:

$${}_1H^2 + {}_1H^3 \rightarrow {}_2He^4 + {}_0n^1 + Q \ (17.6 \text{ Mev})$$

$$\frac{Q}{m} = \frac{17.6}{5} = 3.5 \text{ Mev/mass unit.}$$

LITHIUM BOMB

$${}_3Li^6 + {}_1H^2 \rightarrow {}_2He^4 + {}_2He^4 + Q \ (22.5 \text{ Mev})$$

$$\frac{Q}{m} = \frac{22.5}{8} = 2.8 \text{ Mev/mass unit.}$$

FIGURE 8. Fusion Reactions

per mass unit is $17.6/5 = 3.5$ Mev/mass unit; the reaction is therefore four times as efficient as the fission of U^{235}. This reaction was very probably the basis of the hydrogen bomb exploded by the U. S. at Eniwetok in December, 1952. The plant to make the tritium for this bomb cost the U. S. 1.5 billion dollars. In order to make this reaction proceed, the hydrogen isotopes probably have to be raised to a temperature of about 50,000,000°C. This was probably accomplished by using a fission type bomb as a detonator.

The more recent bomb exploded in the Marshall Islands on March 1, 1954, was probably based on a different reaction involving the fusion of lithium and hydrogen isotopes. This is also indicated in Fig. 8. The energy released per unit of mass is $22.5/8 = 2.8$ Mev/mass unit, only slightly less than that from tritium. ${}_3Li^6$ constitutes almost 8 per cent of ordinary lithium and ${}_1H^2$ constitutes about 1/6000 of ordinary hydrogen. Compared with the tritium bomb, the ingredients of this are quite cheap. They were probably prepared in the form of lithium hydride $Li^6\ H^2$. As before, a very high temperature is needed to make the reaction go and again a fission bomb was undoubtedly used as the detonator.

So far as is known, fusion has not as yet been used as a source of power. The problems are staggering: (1) the high temperature required and (2) the problem of control, i.e., of keeping the reaction from causing an explosion. It seems very possible that these problems will eventually be solved and that fusion will become a practical source of power.

In the meantime, some progress is being made towards solving the problems of how to use fission to provide energy for uses other than bombs. Several companies are working on nuclear-powered aircraft. One nuclear-powered submarine has already been built and another is being constructed. Although the motivation for both these uses, the aircraft and the submarine, is military, nevertheless, the lessons learned could be immediately applied to non-military use if the work were declassified. Also, considerable work on reactors is being done both in this country and elsewhere; a little of this effort is being expended on developing them to produce electric power. Eventually, it is almost certain that some of our electric power will come from reactors. The problems involved before this can occur are threefold.

(1) Technical problems yet to be solved.

(2) Economic problems (competition with other means of producing electric power.

(3) Government policies: declassification of technical information, possession of fissionable material, etc.

In conclusion, it can be said that the discovery of nuclear power from fission and from fusion represents a major development in the history of man.

EARTH SCIENCE PRINCIPLES IN THE SECONDARY SCHOOL

By LOREN T. CALDWELL

Northern Illinois State College, DeKalb, Illinois

MANY RESEARCH STUDIES are reported which deal with the determination of those scientific principles which may best be used as a guide to effective teaching at various levels in our secondary education program. In contrast, research reports are quite sparse and inadequate in suggesting *how* the teacher can employ science principles in the teaching process.

A research study,[1] completed by this author, determined a number of earth science principles as desirable for use in the science program of general education in the secondary school. From a number of earth science principles judged to be desirable by this study, forty-seven of these principles were given the highest rating of desirability by the jury of evaluators for use in the secondary school.[2]

It is the plan of this paper to select from this research report, one statement of an earth science principle and to establish the role which that principle (or concept) may play in the curriculum of the secondary school, grades seven to twelve inclusive. Some of the teacher-planning and student-learning sequences as well as fact-correlating will be cited for the selected earth science principle.

At this time, it may be advisable to consider the general meaning of an earth science principle. Such a principle is commonly considered to be a comprehensive generalization about the operation of related scientific principles on the earth. It must be verifiable by observation or by experiment whereby its truth can be tested. Finally, it must be scientifically true.

In order to illustrate what is meant by learning experiences which lead to an association of ideas and hence to an appreciation of principles, small children observe a stream carrying away earth and are able to see one way in which valleys are cut and hills are formed. As the child grows, his observations, based on similar and related experiences with small, medium, and large streams, become more discerning. This leads him to a more complete understanding of the principle that the earth is old in changes brought on by the operations of scientific principles found in physics, chemistry, and biology. Such approaches to earth science principles give to the scientific principles, from the basic sciences, day-by-day reality and human meaning. Such meanings have great general educational value for the secondary school science program. It may be seen that, since these earth science principles can be stated as objectives of science teaching, they must occupy an important place in a program of science for general education. Since the aim of science for general education is life enrichment, children should be introduced to big ideas early in their learning experiences.

Statement of a highly desirable earth science principle from the area of geology:

> 'The earth's rock surface has been undergoing constant gradual changes by having been built up by deposition and internal forces as well as having been torn down by weathering, erosion, and depression by internal forces.'

The task of studying the changes in land levels for a place from time to time may be approached first through observation. These observations may be elementary in nature by observing such things as the difference in level of a creek bed from year to year to determine whether its channel is filling, cutting downward, or remaining constant. In similar fashion an upland field, the highest area between two creeks or streams, may be observed to determine whether its general surface is level, lower, or higher than an adjacent fence-row level.

In junior high school science, hand levels may be employed to determine the difference in level. Likewise, on the senior high school level, surveying instruments may be employed to make such surface-level measurements.

On a secondary school level of learning, it is highly desirable that field observations be numerous

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[1] Caldwell, Loren T., *A Determination of Earth Science Principles Desirable for Inclusion in the Science Program of General Education in the Secondary School.* Doctor's Thesis, School of Education, Indiana University, Bloomington, Indiana, 1953.

[2] Caldwell, Loren T., "Determination of Earth Science Principles Desirable for Inclusion in the Science Program of General Education in the Secondary School", *Science Education,* 39, No. 3: 196-213; April, 1955.

and varied. Such observations of land levels should extend to an ever-increasing geographical distance from the school grounds as the unit is studied on successive years through the secondary school. If the school schedule limits field trip opportunities, the science program is being jeopardized, but the teacher can turn to the study of topographic maps selected to illustrate land-level values for a given date. Maps of resurveys should show the amount of land-level changes. Due to inadequate resurvey maps showing the calendar date interval, many of the land-level changes by necessity will need to be deduced from the nature of the topography shown on a single map, with data which are accurate, for a given date. All such map studies of past changes will be abstract forecasters of land-level changes which may occur in the area during the years to come. Such deductions may be based upon the nature of work done by natural forces such as follows: faulting during earthquakes to both bodily lifting or lowering of sections of the earth's crust; downward eroding by young streams (or floodplain building by old streams); wind abrasion and deposition; as well as glacial scouring and deposition of rock surfaces.

When the natural applications of an earth science principle have been observed, such observations may be made significant by relating them to the natural application of scientific principles from physics, chemistry, and/or biology whenever they may be identified as causal to the natural application of the earth science principle. This may be illustrated in several ways. Such an illustration is made when the above-stated earth science principle is explained by means of stress forces having accumulated within the earth's rocky crust such as a result of the action of lunar tides on the rock earth; also the unequal density values of the different portions of the earth crust; and also the effects of a shrinking earth's interior upon the deformation of a relatively rigid earth's rocky crust.

A number of scientific principles from the area of chemistry may be related to the above stated earth science principle. Such an association is made when the chemical weathering of rock minerals and the solution action of running and percolating waters are related to the ability of water to alter the surface levels of the rock earth. The solubility quotients of both hot and cold water for the more common mineral compounds can be studied in this case. Likewise, observations may be made of the widespread chemical effects of dilute carbonic acid and organic acid solutions upon the common mineral compounds as these acids occur in rain and ground waters, at and near the surface of the earth.

Natural applications of several physical principles can be employed to explain the action of water, wind, and ice while they abrade, transport, and deposit rock particles in the process of altering the land levels of the earth. Such physical principles as seen in potential energy of fluids, density differences in air, and changes of states of ice with pressure differences should give meaning to the action of water, wind, and ice, respectively. This type of correlation of physical principles with the earth science principle of land-level changes gives quantitative meanings to the land-level changes.

Natural applications of several biological principles can serve to give interpretation to the causal agents involved in the above-stated earth science principle. A few such biological principles may be cited as follows: the erosion-retarding effects of different types of vegetation upon both surface water run-off and wind erosion; the effect of plant roots and burrowing animals upon water absorption into the rocks and soil; and finally, the effect of insolation (sunlight exposure and absorption) upon vegetal cover as compared with its effect upon barren rocks or fallow soil.

It may be evident to the reader that the task of correlating the natural applications in the above-stated earth science principle with some of the natural applications of related scientific principles is quite incomplete as discussed in this paper. However, this author hopes that those correlations which were made here may serve to illustrate the procedure of employing an earth science principle in teaching. Detailed plans for such teaching procedures should be specifically planned by the science teachers of a school system in order to assure that the employment of a given principle results in an improved sequence of integrated learning experiences for each academic level.

In addition to relating the basic science principles with the earth science principles, science teachers can better meet their educational responsibilities by assuming the responsibilities of correlating earth science principles with the related applications of social principles.

It seems evident that much significant history has been made and recorded during past changes of land-levels and during related functions such as the fossilization of plant, animal, and human remains and artifacts. Likewise, the history of climatic change, which has resulted in part from land-level changes, can account for much of biological evolution and for many major human race changes. Although such correlations are long-range in terms of time, they reveal the nature of parallel correlations which are short-range and more difficult to identify.

Elementary Science

MAKING PHOTOGRAPHIC PRINTS IN THE CLASSROOM

By SEYMOUR TRIEGER

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IN RECENT YEARS there has appeared a type of photographic printing paper which may be handled under the lights of an ordinary room. This eliminates the need for a darkroom or special safe-lights in making pictures. With a few simple materials and the ordinary classroom equipment, children and teacher may experience the thrill of seeing a finished picture develop out on the white printing paper before their eyes.

The process is simple enough for children of the intermediate grades to carry out under the guidance of the teacher, or it may be demonstrated by the teacher for children of any age. A brief description follows.

In a double-decker sandwich arrangement, the photographic negative and a sheet of printing paper are held in close contact with each other between a sheet of glass and cardboard, joined by a tape hinge. This arrangement is then exposed to a strong light for a few seconds so that the light passes through the negative to the paper beneath. This procedure results in the formation of an invisible or "latent" image on the paper which must now be developed.

The sandwich is opened and the paper is removed and immersed in the following four solutions:

1. In the "developer," which makes the latent image visible.
2. In the "stop bath," which causes the developer to stop its action.
3. In the "fixer," which renders the paper insensitive to further exposure to strong light and stabilizes the picture.
4. In the wash water, to remove by running water all traces of any of the chemicals used.

The finished print may then be dried and mounted.

Materials Needed

Kodak Velite Paper (Comes in packages of 25 sheets, in popular negative sizes; available at most photographic supply stores.)

Kodak Tri-Chem Pack (Contains all necessary chemicals in easy-to-mix powder form.)

3 dishes, pans, or trays (Enamel, hard rubber, glazed porcelain, or glass of any suitable size or shape to contain a sheet of printing paper plus a few ounces of solution.)

1 large tray, pan, or basin for washing a number of pictures.

100-watt bulb in a reflector (A gooseneck desk lamp is convenient.)

"Printing frame" (Made of window glass and heavy cardboard both cut to size of negative being printed. Join along one edge by a cloth tape hinge.)

Miscellaneous (Measuring glass, paper towels, thermometer, etc.)

Procedure

1. *Testing safety of room lights.* Although the usual darkroom and dim yellow safe-light are unnecessary, this does not mean that any amount of light will be tolerated by this light-sensitive paper without premature exposure. To test your work light, lay a small piece of Velite paper, shiny side up, on the worktable and cover half of it with a piece of opaque paper or a book. After two minutes, develop it according to the instructions below. If the exposed half is darker than the half which was covered, reduce the room lights accordingly and make the test again. (Tungsten light is recommended as a work light because you can use a surprising amount of it without exposing the paper. Fluorescent lights are less safe and require the above test.)

2. *Making the print exposure.* Arrange the materials in the "sandwich" in the following order: On the cardboard, place a sheet of Velite paper shiny side up. On top of this, place the negative shiny side up. Close the glass top of the frame. A 100-watt bulb in a reflector is held about eight inches away from the "sandwich." Negatives of

average density will require an exposure of 20 seconds. "Thin" negatives will need less light and "dense" negatives more. Although there is a certain margin of error in exposure that will be accepted by the printing paper, it is, of course, always advisable for the teacher to try out any demonstration before using it with the children.

3. *Developing the picture*. All solutions work best at a temperature of about 68° Fahrenheit.

(a) After exposing the paper, develop it for 60 seconds in the developer solution. If the print is too dark within 45 seconds, try another exposure half as long; if too light after 2 minutes development, make the next exposure twice as long. Allow the excess liquid to drain off the print for a few seconds and . . .

(b) immerse it in the stop bath, moving it around briskly for at least 15 seconds. Drain print and transfer to . . .

(c) fixing bath. Prints remain here for 5-10 minutes. From time to time move the prints so that they do not cling to each other. This will prevent the fixer from acting on them. Drain and . . .

(d) wash for one hour in running water in a large pan or tray. Do *not* use warm or hot water!

(e) Dry prints by placing them face down on a clean white cloth under which may be placed a white blotter or other absorbent paper such as newsprint. Cover prints with a layer of newsprint or blotting paper. Place books or other weights on top and let dry for 12 to 24 hours.

Explanation and Photographic Theory

The printing paper is coated with a light-sensitive layer of a silver compound dissolved in gelatin. Light causes this silver compound to break down into very fine grains of silver and other products. These minute grains of silver make up the picture.

No darkening of the paper results from this first exposure to light. The image is "latent," or hidden, and must be developed. The developer completes the break-down process and makes the silver grains visible as a picture.

Those portions of the negative which are most transparent transmit the most light and cause more grains of silver to appear as the dark areas of the picture. Those portions of the printing paper under the denser sections of the negative receive the least amount of light (fewer silver grains released) and appear as the gray and white areas of the picture. The paper will therefore reproduce the negative as a range of shades from black to white with all intermediate grays.

In this manner the negative has been made to produce a "positive," or a finished picture.

Laboratory Exercises for the Life Sciences

A SERIES OF EXPERIMENTS, DEMONSTRATIONS, AND NEW IDEAS

(Continued from the March issue of *The Science Teacher;* concluded in the May issue.)

This is the second of three features to bring to our readers the entire series of ten experiments and demonstrations which were presented at the Cancer Information Conference held last October 15 at the National Cancer Institute. These experiments and demonstrations in biology, chemistry, and physics illustrate techniques and lines of investigation actually used by "real, live scientists" in the research work they do at NCI. They are included in response to the many requests for activities to add realism to high school science and to enkindle the enthusiasm of students.—*Editor.*

RADIOACTIVITY AND ISOTOPIC TRACER STUDIES

By JAMES C. REID, Ph.D.
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THE DISCOVERY OF RADIOACTIVITY is one of those many examples which may be taken from the history of science that illustrates the difficulty, if not the impossibility, of evaluating the utilitarian worth of a discovery at the time it is made. Surely no one could have foreseen in the closing years of the last century the many uses to which this interesting phenomenon has been put in our time. One of the most important uses is the employment of radioactive compounds for tracer studies of chemical reactions, particularly those occurring in the living organism. Such studies make use of "labeled" compounds that contain in their molecules, atoms that are radioactive, and the course of these compounds (and some of the compounds derived from them) can be "traced" in the body. This "tracing" can be accomplished since the unstable nature of radioactive atoms leads to expulsion of particles which produce ionization that can be detected by suitable instruments. Many chemical reactions of the living organism have been discovered with the aid of radioactive tracers; most of these discoveries would have been impossible without the sensitive methods of tracer technique. These "tracers" are also of aid in our attempts to measure rates of the reactions occurring in the body and in trying to understand some of the complex interrelations of the various reactions. Radioactive carbon is one of the most important isotopes since so many of the chemical substances important in the functioning of living organisms contain carbon.

One type of tracer study of great interest for many fields of biology and medicine is work on protein synthesis in which the amino acids that make up protein are administered in a form labeled with radioactive carbon. We still do not know the mechanism involved in the synthesis of protein, but tracer studies are providing interesting leads for future work. Since tumors are producing protein at an appreciable rate and this protein must be different from that found in the organ from which the tumor arose, these studies are of primary importance in cancer research.

Teaching about the instruments used for the detection of radioactivity can be utilized in giving reality to the story of radioactivity and its various applications, such as tracer research. Two simple demonstrations for the detection of radioactivity are given below.

DEMONSTRATION 1

Purpose: To demonstrate the existence of invisible radiation emanating from radioactive material.

Method: The radiation is detected by its ability to ionize air. The detection instrument is an electroscope. The electroscope is charged and it is observed that the leaves fly apart and remain separated. When a radioactive source is brought near the instrument the leaves are observed to move slowly back to their normal position as the charge is neutralized by the ions which the radioactive source produces in the surrounding air. This experiment presupposes that the student understands the basic phenomena of electrostatics.

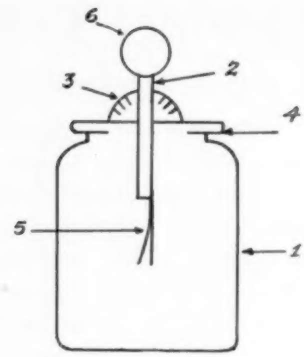
Materials and Procedure: An alarm clock with a luminous dial is a suitable source of radiation which is easily obtained. The glass face is removed from the clock since it absorbs a large fraction of the radiation. A comparatively high radiation intensity is required for this experiment and a watch cannot be substituted for the clock satisfactorily.

If an electroscope is not available one can be put together very easily in the manner illustrated in the accompanying sketch. The only feature of the construction which requires comment is part #4, which insulates the inner assembly from ground. The insulation must be of high quality, otherwise the electroscope will not hold a charge and the leaves will slowly fall together instead of remaining separated. Lucite is recommended. If Lucite or Bakelite is not available glass plates covered with a layer of Saran Wrap may be tried. The insulators must be clean and dry. If the weather is particularly humid, difficulty with charge leakage may be encountered even with good insulators. In the winter however this is not likely.

To carry out the demonstration, a plastic object such as a comb is given an electrostatic charge by being rubbed rigorously against a piece of wool or drawn through the hair. It is then brought into contact with the knob of the electroscope, whereupon the leaves fly apart. With the charged object still in contact with the knob, the rod is touched momentarily with a finger and charge flows from ground to the leaves, neutralizing the induced charge which they bear and causing them to fall together. Now the finger is removed and then the charged object, leaving the rod with a net excess of charge, which, freed of the polarizing influence of the charged object, redistributes itself along the rod. The leaves therefore fly apart again and will remain apart so long as the charge on the inner assembly does not leak off.

The operator now brings the radioactive source to within six inches of the top of the electroscope. The leaves will gradually fall together as the ions produced in the surrounding air by emanation from the source neutralize the charge on the electroscope.

Since the movement of the leaves is gradual and the excursion is not very great, close observation is required to see the effect. The effectiveness of the demonstration is very much increased if an enlarged shadow of the leaves is projected on a wall or screen by placing the electroscope between a strong light source and a lens which is focused on the leaves. The movement of the leaves is then very easily visible to a roomful of people.



SIMPLE ELECTROSCOPE

1. Large wide-mouth bottle.
2. Stiff metal rod.
3. No. 6 rubber stopper.
4. Insulating plates of ¼ inch Lucite or Bakelite.
5. Strips of gold leaf or very thin tissue such as lens tissue or a single thickness of Kleenex. If paper leaves are used they are inked with *India* ink to make them electrically conducting. Do not use silicone-treated lens tissue. The leaves are taped to the end of the rod and must be in good electrical contact with it.
6. Rounded metal knob. This is necessary to prevent charge from leaking off at sharp edges at the end of the rod.

DEMONSTRATION 2

Purpose: To demonstrate the existence of invisible radiation emanating from radioactive material and its ability to pass through solid matter.

Method: A photographic film wrapped in black paper is placed in contact with a radioactive source. After a suitable time, the film is developed and is observed to be blackened where it was in contact with the source. It is thereby demonstrated that the source emits invisible radiation which will sensitize photographic film and which will pass through a thickness of paper.

This experiment involves the principles of photography. This aspect can be developed as part of the experiment if it is so desired but will not be discussed here. It may be mentioned that the discovery of radioactivity by Becquerel came about accidentally as a result of his placing an ore specimen near some film and subsequently noticing that the film had become fogged.

Materials and Procedure: An alarm clock with a luminous face is an ideal radiation source and is easily obtainable. A luminous wrist watch dial can be used but the radiation is less intense because of the thinness of the radium paint. If the glass is removed from the clock face the necessary exposure time will be considerably shortened. Alternatively the glass can be left in to emphasize the ability of the (gamma) radiation to penetrate solid matter.

Any type of photographic film can be used. Medical X-ray film is best if available because of its high sensitivity to nuclear radiation. Lacking this, ordinary orthochromatic sheet film is best. Orthochromatic film can be handled in a red safe-light, unlike panchromatic film which requires total darkness. Sheet film is better than roll film because of difficulties with curling of the latter.

In a dark room a piece of film is placed in an

envelope made of light-proof black paper, whose flap is then secured with tape. After the film has been enclosed, it can be brought into the light and placed emulsion side up on a table. (The emulsion side of the film is the side toward which the film tends to curl.) The clock dial is placed against it and left there until sufficient exposure has been given and the film is then developed. A good alarm clock with the glass face removed will give a faint image in an hour or two but a more striking demonstration is obtained with an exposure five or ten times as long. A wrist watch will require somewhat longer. The instructor is advised to try this experiment himself before giving it to the class in order to determine the exposure time necessary with his particular clock and avoid a failure due to insufficient exposure. If it is desired to produce a clear image of the clock face it is necessary to secure close contact between the film and the face. Normally, because of scattering of the radiation a smudge image is obtained which however, is sufficient for the purpose of the experiment.

TISSUE CULTURE

By JOSEPH LEIGHTON, M.D.

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Principles: Tissue culture is a technique by which living tissue can be grown outside the living organism. It is one of the important methods for studying the processes of life, especially since it allows greater control over some of the factors in the environment of the cells than can be obtained while the tissues are growing within the body. Information important for our understanding of these processes, both as regards the structure of tissues as well as chemical activities related to them, can be obtained from these studies.

One of the very fundamental problems of biology is that of the relationship of one kind of tissue to another and, more particularly, how one type of tissue becomes transformed into another type. Such a transformation occurs continuously as the fertilized egg goes through the various stages of development to the adult organism. Such a transformation occurs when a normal tissue becomes tumorous. A related problem is how do tissues assume their final structural form. We need to know very much more about these changes, along with more knowledge about growth of tissue. Tissue culture studies, as well as embryology, can help us understand better these complex relationships and, perhaps, how cancer originates and grows.

Certain tissues can be kept alive outside the body for many years if the nutrient fluid is repeatedly changed and the size of the growing culture is maintained at a proper level. Tissue cultures are available that were started from isolated single cells growing in culture themselves. It is of great interest to note that in the subsequent generations of offspring from these single cells, the cells are not all alike and different sub-lines develop, all coming originally from a single cell. Likewise, it has been shown that a change sometimes takes place in the tissues that have been cultured for some time leading to the development of cancer cells in the culture.

The application of chemistry to tissue culture studies is becoming a major part of these studies and has been made possible because the ground work has been laid by the many biological studies in tissue culture and by advances in chemical techniques. We can look forward to many important advances in our understanding of cell functioning through these studies.

The tissues of the chick embryo are commonly used because of their availability and ease of cultivation. The kinds of chambers used vary with the amount of tissue cultivated, the types of observations to be made, and the duration of the experiment. Tube cultures are the simplest, least expensive, and most versatile of the glass chambers. The principles of the technique have a foundation in physiology, and will be recognized as biological common sense. Fragments of tissue must be cut rapidly and cleanly, without crushing and without contamination or excessive drying. They are planted in the culture medium, and the tube is stoppered and incubated. Sterile technique must be employed to avoid contamination by growing bacteria.

The liquid medium may be thought of as approximating the intercellular fluids of the body in composition. Actually, mammalian serum diluted with a balanced salt solution, and some embryonic tissue extract is used. Cells may be grown on the bare glass wall of the tube, in a plasma clot (as cells grow in the body in the site of a healing wound) or in a plasma clot reinforced by a cellulose sponge matrix. This last method permits three dimensional growth, more nearly like that seen in the body. Such cultures permit one to observe the living tissues, and also may be studied with the same histologic techniques as used by pathologists in studying tissue from the patient.

Procedures: *Comments on Sterile Technique and Sterilization:* Since the culture media employed in tissue culture are also good media for the growth of bacteria, care must be taken to insure the absence of bacteria from the culture. In addition to working with sterile materials, an attempt must be made to avoid contamination when the cultures are being started. Thus, it is advisable to make no unnecessary movements that would tend to stir up the dust in the room, to avoid talking, to hold open vessels at an angle rather than upright and to close them as soon as possible, and to avoid touching sterile portions of materials with non-sterile objects, since these actions all tend to reduce contamination by bacteria. Speed of operation is important since the shorter the time the sterile areas are exposed, the less likely is contamination to occur.

The equipment is best sterilized by autoclaving at 121°C. for 20 minutes. If an autoclave is not available, a pressure cooker can be employed in its place. Glassware can also be sterilized by heating in dry heat in an oven at 160°C. for 2 hours. Instruments can be sterilized by letting them stand in 95% ethyl alcohol in a cylindrical container with the portions to be grasped out of the alcohol, and when ready for use they are removed and the alcohol that adheres to the instrument is ignited in a flame. They are again placed in the alcohol and again removed, and the alcohol on the instrument is ignited a second time. They are used as soon as they have cooled.

The equipment that is sterilized by autoclaving or by dry heat is either wrapped in paper or is placed in storage containers such as cans or screw-cap glass containers,* prior to sterilizing. All equipment must be clean before it is sterilized.

The solutions used for preparing the media can be purchased in sterile form. The amounts required are removed from the bottles with a sterile needle and syringes after the rubber cap on the bottle is first wiped off with a piece of sterile cotton saturated with 70% alcohol.

Forceps (sterilized by flaming) are useful for manipulating sterile objects without contaminating them.

Materials:

For media:

1. Serum—almost any will do, e.g., horse, ox, calf, rabbit, or human. Four cc. are sufficient for 6 cultures.
2. Balanced salt solution—Hanks' solution is easy to use. Four cc. are required for 6 cultures.
3. Chick embryo extract. Two cc. are needed for 6 cultures.
4. Heparinized chicken plasma. About 1 cc. is sufficient for 6 cultures.
5. Antibiotic mixture (from Microbiological Associates, Inc.). Four drops are needed for 6 cultures.

These components can be purchased from Microbiological Associates, Inc., Bethesda, Maryland or from the Difco Company, Detroit, Michigan.

Equipment:

1. Syringes and needles. Two syringes at least 5 cc. capacity, two of at least 1 cc. capacity, and one of at least 2 cc. capacity. The needles should be about ¾ inch long and about 18 to 20 gauge. They are sterilized in cans or wrapped in paper.
2. Pipettes. Straight and curved tipped pipettes about 18 to 19 cm. in length are made from glass tubing, outside diameter 7 mm., so that the smaller opening is 1½ to 2 mm. in diameter. Prepare 5 or 6 each, of the straight and curved type, and, after equipping with medicine dropper rubber bulbs, sterilize by autoclaving in a can or wrapped in paper.
3. Culture tubes. Test tubes, 16 x 150 mm., Pyrex are used. Sterilize in cans or wrapped in paper (a dozen or so tubes are needed).
4. Rubber stoppers to fit the culture tubes. Sterilize a dozen or so by autoclaving in a screw-cap jar (if a square jar is used it can be placed on its side without rolling).
5. Flat dishes, such as Petri dishes. Sterilize two of them wrapped in paper.
6. Cylindrical jar, such as a Coplin jar. This vessel, with cotton in the bottom, is nearly filled with 95% ethyl alcohol to hold the instruments.
7. Instruments. Two number 7 Bard-Parker knife handles with number 11 blades. An extra supply of blades is needed if cultures are to be prepared on several occasions. A pair of small dissecting scissors are required. Two pairs of forceps are needed: one pair, 4″ long (preferably with fine teeth), for dissecting; one pair 6″ or 7″ long for handling sterile objects. The instruments are stored in the jar of alcohol and are sterilized by flaming immediately before use.
8. An incubator. The cultures are grown by placing them in an incubator set at approximately 37° C.

* Care must be exercised if screw-cap vessels are used in autoclaving since there is chance for breakage; the caps should be loose until the autoclaving is finished.

9. An autoclave. A pressure cooker can be substituted (see comments on sterilization above).

Sponge: A new fine-pore cellulose sponge, such as is used in photographic work, made by duPont, is needed. Cut into inch long strips, 5 x 10 mm. in cross section. Compress the strips between glass slides and cut transversely with a single edge razor blade into slices 0.5 mm. thick (discard any slices 1 mm. or thicker). Wash the remaining slices by boiling twice in distilled water. Place each slice in a clean tube, 16 x 150 mm., and stopper. Sterilize by autoclaving.

Preparing the cultures: *Preparation of the medium:* Using a separate sterile syringe as described above for each component of the medium, the following amounts are removed and mixed together in a sterile culture tube:

Serum	4 cc.
Hanks' balanced salt solution	4 cc.
Chick embryo extract	2 cc.
Antibiotic mixture	4 drops

Mix by drawing portions up into a sterile pipette several times. Stopper the tube with a sterile stopper. (If a centrifuge is available, it is preferable to centrifuge the mixture to assure clarity of the medium, thus allowing better observation of the growth. Care must be taken that the tube is not broken during centrifugation by too great a speed of the centrifuge; if water is placed in the cup around the tube, a cushioning effect will help prevent breakage. The clear over-lying supernatant solution is transferred to another sterile tube). The amount should be ample for six cultures.

Preparation of the tissue: A fertilized egg (8- to 12-day-old embryo) is candled, and the embryo is removed with sterile instruments and placed in a sterile flat (Petri) dish. With sterile Bard-Parker knives used in scissors fashion, the embryo is cut up into small squares; *sharp clean cuts* are made by drawing the knives simultaneously in opposite directions. The optimum size of the squares is 1 mm. edge, and the squares unsuitable (irregular shapes, crushed or torn tissues) are rejected. A few suitable squares are moved to one side and washed with a minimum amount of sterile medium (a sterile pipette is used) necessary to remove debris and small fragments. Then the selected fragments are surrounded by a small amount of medium.

Setting up the cultures: Cultures are set up in two types of tubes:

(1.) Sterile tubes containing a thin plasma clot. The thin clot is prepared by coating the lower ⅓ of the tube with a drop of sterile chicken plasma (a sterile bent capillary pipette is used). Clotting will occur only after the addition of the media in the next step.

With another sterile pipette partially filled with some medium, three of the suitable squares of tissue are drawn up into the pipette. These squares are then arranged in a row on the wall of each tube. The tube with the plasma is rotated to mix the plasma and the medium. When the plasma has coagulated to a firm consistency, 10 drops of medium are added to each tube. The tubes are stoppered with a sterile stopper, labeled, and placed on their sides, at a slight angle, so the fluid is over the tissue squares, but is not over the rubber stopper. In this position the tubes are kept at approximately 37° C. After two days the tubes are examined under the microscope at 100 x or less, and new cells extending out from the original pieces of tissue can be seen. The tissues can also be fixed, embedded, cut, stained, and mounted just as other tissues are handled for the preparation of microscope slides.

(2.) Sterile tubes containing a cellulose sponge slice and a plasma clot. A sterile bent capillary pipette is used to coat the lower ⅓ of a sterile culture tube with a drop of chicken plasma. A sterile sponge strip is moved into the coated area with the plasma pipette. With a second pipette partially filled with medium, take up three suitable squares of tissue into the pipette, and place them on the surface of the sponge. Quickly irrigate the sponge with the plasma-medium mixture (produced in the culture tube from the plasma coating and the medium introduced with the three squares of tissue). Remove any excess and lay the tube on its side with the sponge on the lower wall. After clotting has occurred and the clot is firm, add ten drops of liquid medium to the tube, stopper and incubate at 37° C. as above. Microscope sections can be made of the sponge with the tissue in its pores.

It is strongly recommended that the following reference be consulted. ***An Introduction to Cell and Tissue Culture,*** by the Staff of the Tissue Culture Course, Cooperstown, N. Y., 1949-1953. Burgess Publishing Co., 426 So. 6th St., Minneapolis, Minn. (1955). $4.00.

TECHNIQUES IN MICROSCOPE SLIDE PREPARATION

By JOSEPH M. ALBRECHT

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Principles: The making of microscope slides is not only useful for producing valuable material for classroom instruction, but is also an excellent means of stimulating the student's interest in science, both through learning about the biological material as well as through the actual techniques of preparing slides. Slides of smears of blood from different species of animals, of plant tissues, of the different kinds of tissues from different animals, of small whole animals, of living organism in different stages of embryological development, and of many other materials can all be used to great advantage in the teaching of science. Through the use of different staining materials the relationship to chemistry can also be brought into the picture.

This demonstration is designed as an example of a useful technique for producing microscope slides of thin sections of animal tissues, making use of a minimum amount of equipment and materials. The technique involves the following steps:

1. *Fixation of the tissues:* In order that the structural features present in the living tissues be retained in a thin section of the tissue, some method of "fixing" these features must be employed. This "fixing" is accomplished by placing the tissue in a material that causes the protein in the tissue to precipitate in an arrangement much like that found in the living state. This "fixing" also hardens the tissue, thereby aiding in maintaining the structural arrangements when the tissue is sliced.
2. *Dehydration and embedding:* In order to make thin slices of the tissue some support must be given to the tissue components during the cutting process. This support is conveniently supplied by infiltrating the tissue with melted paraffin and then letting the paraffin solidify. Since paraffin is not soluble in water, the water present in the tissues must be replaced with a liquid (such as xylene) in which the paraffin is soluble. If the water is removed too rapidly, distortion of the structural arrangements of the tissue occurs. Consequently, the water is removed gradually by passing the tissue through successive changes of alcohol-water solutions with increasing concentrations of alcohol until absolute alcohol is reached. Since xylene is soluble in alcohol, the tissue can be transferred from the absolute alcohol to the xylene and then into the molten paraffin.
3. *Cutting of sections:* Thin slices of the paraffin containing the tissue are cut with a sharp blade. The sections must be thin enough to allow sufficient light to pass through them to permit visualization. After sectioning the paraffin is removed with xylene.
4. *Staining of the sections:* In order that the structures of the tissue may be visualized, they must be stained with dyes. Two useful dyes are hematoxylin, which is taken up by the cell nucleus imparting a purple color to it, and eosin, which is taken up by the cytoplasm of the cell imparting a pink color to it. Again different concentrations of water-alcohol solutions are employed since the hematoxylin is soluble in water, but the eosin is not. For permanent preparations a thin glass cover slip is placed over the stained section of tissue and sealed with a resinous mounting material.

Procedures: A. *Preservation or Fixing of Tissues*

1. After the tissue is removed from the animal, immediately cut it into blocks of tissue no larger than 1 cm. x 1 cm. x ½ cm. and fix for 24 hours in 10% Formalin (1 part Formalin—9 parts water).
2. Wash off excess fixative in several changes of tap water.

B. *Dehydration and Embedding of Tissues*

1. Place tissue in 50% ethyl alcohol* for 1 hour.
2. Place tissue in 70% ethyl alcohol* for 1 hour.
3. Place tissue in 80% ethyl alcohol* for 1 hour.
4. Place tissue in 95% ethyl alcohol* for 1 hour.
5. Place tissue in absolute alcohol* for 1 hour.
6. Place tissue in a second portion of absolute alcohol* for 1 hour.
7. Place tissue in xylene for 2 hours, or until translucent.

} Use about 20 cc. of each solution per block of tissue.

* The school doctor or a local physician should be able to help obtain this material.

8. Place tissue in melted paraffin to infiltrate tissue with paraffin (melting point 56°-58° C.) using three changes of paraffin, 1 hour each.
9. Embed tissue in tray or dish, permitting paraffin to solidify. (If a larger tray is used containing several blocks of tissue, make sure the blocks are not near each other when the paraffin hardens).

C. *Cutting of Sections*
1. After trimming away the excess paraffin from around the block of tissue (leaving a margin of excess paraffin about ⅛ to ¼ inch thick), the paraffin block in which tissue is embedded is placed on a disc or holder.
2. The holder is then placed in a chuck on the microtome (sectioning apparatus). (If no microtome is available, the block and holder can be held in the hand).
3. Sections are cut, using the microtome or a very sharp blade. The sections should be as thin as possible if cut by hand, or about 7 microns if cut with the microtome.
4. Sections are floated on warm water to flatten them and remove wrinkles.
5. One to four sections are then stuck to a microscopic slide that has had smeared over it a diluted solution of egg albumen, and they are then permitted to dry. They are then ready for the staining procedure.

D. *Staining Procedure:* Cylindrical jars, deep enough to hold enough solution to cover most of the slides when they are standing on end, are employed for steps 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, and 13 below.
1. Xylene—5 minutes—(Removal of paraffin).
2. Xylene—5 minutes—(Removal of paraffin).
3. Absolute alcohol—3 minutes.
4. Absolute alcohol—3 minutes.
5. 95% alcohol—3 minutes.
6. Wash in distilled water—3 changes.
7. Stain in Mayer's hematoxylin 1-2 minutes.
8. Wash in running tap water until sections turn blue. (Do not place sections *directly* in the stream of water or they will be lost from the slide).
9. Rinse in distilled water.
10. Stain with 1% alcoholic eosin—30 seconds to 1 minute.
11. Wash in 95% alcohol until excess eosin is removed—2 changes.
12. Dehydrate in absolute alcohol—2 changes —each 3 minutes.
13. Clear in xylene—2 changes—3 minutes each.
14. Wipe off excess xylene around section with soft cloth not allowing section to dry.
15. Place one or two drops of mounting medium (synthetic resin) on center of section and lower cover glass onto section, thus making a permanent microscopic preparation of the tissue. Care should be exercised that air bubbles are not trapped under the cover glass.

TRANSPLANTATION OF TUMOR TISSUE

By MRS. DOROTHEA FITZGERALD
Laboratory of Chemical Pharmacology, U. S. National Cancer Institute

Principles: Since the closing years of the last century man has been transplanting bits of tumor tissue from one animal to another of the same species. By this procedure he has provided himself with an invaluable tool for the study of cancer, for it has given him an almost unlimited amount of tumor tissue, growing in an animal host where the relationships between tumor and host can be studied under various sets of conditions. The effects of many factors, e. g., dietary components, hereditary constitution, radiation, hormones, and drugs, can be investigated, both as to how they affect the percentage of successful transplantations obtained, as well as noting how they affect the rate of growth of the tumors and the length of life shown by the tumor-bearing hosts. Likewise, studies demonstrating the effects of tumors on the hosts are conveniently made by employing transplanted tumors. Since these tumors usually grow rapidly, much can be saved in time, effort, and cost in using this technique rather than utilizing only those tumors that occur spontaneously in experimental animals. It is of interest that human tumors can be made to grow in certain laboratory animals, such as the hamster and the rat, if these animals have been treated with radiation or the adrenal gland hormone, cortisone.

Procedure: An excellent tumor for demonstration purposes is a malignant connective tissue tumor

(sarcoma), designated Sarcoma 37, a tumor that grows well in mice. It is easily transplanted, and almost all of the transplantations lead to successful growth. Four days after implantation of a small piece of the tumor just under the skin of a mouse, a new tumor is large enough to be felt easily and in most cases can be seen as a nodule under the skin. By the seventh day the tumor can be seen as a prominent mass at the site of injection. The tumor grows rapidly and will eventually kill the animal, usually in about three weeks.

Six or seven-day-old tumors are usually used for transplant material because at this time the tumor is well established, is growing rapidly, and is relatively free of areas of dead cells, which are found in the center portion of older tumors.

It is important that sterile technique be used during the transplantation to avoid bacterial infection of the tumors. The donor mouse is killed by cervical dislocation. (Hold the mouse down firmly below the skull and dislocate the cord by a quick tug on the tail. This method is quick and painless). The mouse is then pinned to a board, and swabbed with 70% alcohol. Using sterile instruments (prepared by boiling them for 20 minutes in water and allowing them to cool) the skin over the tumor is slit and peeled back, exposing the tumor. The tumor is quickly removed and transferred to a sterile flat dish. Here the tumor is minced with scissors into pieces that are small enough to be drawn into the trocar.* A normal mouse is prepared to receive the implant by shaving the skin area through which the trocar will be inserted.

This area is swabbed with alcohol and the piece of tumor tissue is then injected under the skin or into the muscle. After implantation the animals are returned to their cages and examined periodically for tumor growth. Water and the usual food (e.g., Purina Fox Chow pellets) is supplied.

The effects of various factors on tumors, such as diet or drugs, may be tested either by comparing the size of tumors in treated and untreated animals or by examining the tumors for evidence of damage to the tumor cells, as for instance, hemorrhage or breakdown of the tumor tissue (necrosis).

* A large needle with a plunger can be obtained from Randall-Faichney, Inc., Boston, Mass.; 3", 12 gauge with lap-fitted plunger.

Materials:

Trocar
Scissors
Forceps
Scalpel or razor
Small wooden board
Flat dish, such as a Petri dish
Push pins
Facilities for sterilizing instruments
Mice (no specific strain necessary)
Tumor tissue (Tumor-bearing animals can be obtained from various cancer research laboratories)

See page 99 of the March 1956 issue for "Representative Sources for Supplies" for these experiments and demonstrations.

To be continued and concluded in the May issue of *The Science Teacher*.

SCIENCE TEACHER RECOGNITION AWARDS

An NSTA Staff Report

THE FOURTH AND FINAL YEAR of this program, sponsored by the American Society for Metals and conducted by The Future Scientists of America Foundation, brought forth very promising new ideas for science teaching.

The brief descriptions of the entries which follow will allow interested readers to exchange correspondence with the authors of the ideas.

Robert B. Leitch, Lincoln Junior High School, Santa Monica, Calif., received the $400 award for his report of a ninth-grade general science course to meet the special needs of exceptionally talented students.

John L. Ewart, Phoenix Union High School, Ariz., reported a teaching unit on atomic energy. He received the $300 award.

For his outstanding example of how a science teacher can use community resources, **George W. Hall** received the $200 award. Mr. Hall teaches chemistry in the Central High School, Tulsa, Okla.

Alfred Lazow, Haven School, Evanston, Illinois received the $100 award for his detailed account of science principles that can be drawn from a classroom activity involving chick incubation.

The remainder of this report gives the name, school, and a brief phrase describing the science teaching idea featured in the entry of all other teachers who participated.

John E. Armstrong, Central H. S., Pueblo, Colo. Laboratory problems chosen from the immediate environment of the students rather than from a "cook book" laboratory manual.

William Barish, Jenkintown H. S., Pa. A scoring stencil to mark true-false tests: an aid for teaching a periodic table.

Alfred D. Beck, Board of Education, Brooklyn, N. Y. A treasure hunt conducted by students seeking insects, plants and seeds, and other nature materials to be turned over to science teachers for use as visual aids in the study of natural science.

William Berman, Samuel J. Tilden H. S., Brooklyn, N. Y. Bacteriological techniques, preparation of physiological solutions, precision measurements, dissection, use and interpretation of statistics, identification keys and evaluation of research sources. (Superior students).

Harold G. Boese, Emmerich Manual Training H. S., Indianapolis, Ind. Activities leading to yard beautification and public park landscaping.

Walter D. Bowlby, Miami Public Schools, Fla. Comic charts as a motivating device.

Margaret C. Britton, Villa Cresta Elementary School, Baltimore, Md. Young children's science lessons that were motivated by a snowfall.

Ray Broekel, Jacksonville, Ill. Collected money by selling seeds, set up a shopping list (ant colony, rock hammers, lenses, motor kits, etc.), formed groups (telescope, microscope, etc.,), and organized a program of research projects (Hurricanes, Their Causes and Effects, Animal Life in Lake Jacksonville, Problems in Constructing the City's New Pipe Line to the River, etc.).

Mrs. J. E. Brown, Red Bank H. S., Chattanooga, Tenn. General comments on the use of reports as class activities.

Samuel C. Brownstein, George W. Wingate H. S., Brooklyn, N. Y. Personality development cooperatively worked out by English, social studies, and science departments.

Phyllis B. Busch, Abraham Lincoln H. S., Brooklyn, N. Y. Does understanding the vocabulary and ideas make learning easier? The effect of silence upon the ease of learning.

M. Blanche Cochran, Scott Senior H. S., Coatesville, Pa. Crossword puzzles in teaching science vocabulary.

Monroe Cravats, Junior H. S. 171, Brooklyn, N. Y. General comments on enriching the classroom activity.

Rosalie C. Crenca, Kramer Junior H. S., Washington, D. C. Suggestions for solving time-budget problems.

Margaret Crispin, Martins Ferry H. S., Ohio. Lessons growing out of "Science Is Classified Knowledge."

Marian J. Cummings, Monroe H. S., Rochester, N. Y. Exceptionally well-developed science lesson growing out of interest in baking bread.

David M. Dennis, H. H. Hahn Campus School, Wayne, Neb. The early identification of superior science students and appropriate projects for them.

Ralph H. Dillon, Oskaloosa H. S., Iowa. Realizing that his students in qualitative analysis enjoy "unknowns", he developed several new problems that added as he put it "frosting on the cake."

Marjorie Doyle, Berkeley H. S., Calif. Worksheets to supplement students' chemistry laboratory activities and to help review subject matter.

Frank Eller, Myers Park H. S., Charlotte, N. C. At pre-registration late in the spring semester, each pupil currently enrolled in physics and chemistry was given three copies of an application for reservation of a place in the physics and chemistry classes. These students try to sell prospective students on these classes. Having used this method to keep up his enrollment, Eller then relies upon project-centered activities to maintain interest.

James J. Engel, Brooten Public School, Minn. Teachers should invite students to come to the science laboratories in their spare time.

Ruth Essig, Los Angeles Schools, Calif. A dozen or so elementary science activities with a special emphasis on how they show "balance in nature."

John F. Etten, Parker Elementary School, Chicago, Ill. A brief on the use and value of visual aids in the teaching of science.

Albert C. Finley, Choteau H. S., Mont. "Preview", "points to be observed", and "follow-up tests" which will help students benefit from seeing films.

J. B. Forster, Mark Keppel H. S., Alhambra, Calif. Effectiveness of parties in his own home to keep up student interest in his science courses.

John C. Fullerton, Urbana Junior H. S., Ohio. A brief for the use of comic books of the GE and Westinghouse type in the teaching of science.

Robert L. Gantert, Alexander Hamilton Junior H. S., Seattle, Wash. The special advantages and opportunities of a science club for junior high school students with an A average.

Paul D. Garnett, Lincoln H. S., Portland, Ore. Using the tachistoscope to teach number combinations to slow learners.

Jeanne L. Gelber, Baytown H. S., Texas. Science teaching activities, especially chemistry, which students find stimulating and former students, teachers of science, and administrative personnel believe to be interesting and worthwhile.

Frank W. Gilleland, North Phoenix H. S., Ariz. "Blind for a Day", an experiment to stimulate interest and imagination in fields of light, sound, touch, and human nature.

Rolland J. Gladieux, Kenmore Senior H. S., N. Y. Bringing many community resources to bear on solutions to science-teaching problems.

Wallace M. Good, Wyandotte H. S., Kansas City, Kan. Students who can outline acceptable science projects are introduced to professional scientists who serve as consultants.

Mrs. E. Gray, Forest Hills H. S., N. Y. Transforming the drudgery of biology drawings into really creative art activities.

Donald S. Grothe, Birmingham H. S., Mich. Using projects to overcome suspicions that high school science repeated grade school content and involved only "foreign" interests.

Theodore E. Guglin, John Marshall H. S., Rochester, N. Y. Capitalizing upon local military reserve units, a complete teletypewriter system was set up in the school to help the students understand the principles involved.

Paul L. Guptill, North Fulton H. S., Atlanta, Ga. Mobiles to provide random observations for showing the classical genetics ratios of dominance and recessiveness.

Millard Harmon, John W. Weeks Junior H. S., Auburndale, Mass. How to fully exploit a field trip.

Katherine Hertzka, Hoke Smith H. S., Atlanta, Ga. Guide sheets to help untrained and inexperienced boys and girls adjust to the chores and responsibilities of laboratory assistants.

Ida Hill, Alice Deal Junior H. S., Washington, D. C. A method for demonstrating the Brownian movement and suggestions for making ninth-grade general science students' notebooks functional.

Walter A. Hohn, Jonathan Dayton Regional H. S., Springfield, N. J. Suggested topics for twelve physics laboratory exercises.

Mary Ellen Hurlburt, Iowa State Teachers College, Cedar Falls. Adapting conservation training to teaching arithmetic and social studies.

Ernest C. Husson, Charleston H. S., W. Va. Visual aids designed especially for teaching of circles, congruent triangles, and the human skeleton.

R. H. Johnson, Baltimore City College, Md. A very clever mechanical model of the convex lens.

Vivla Johnson, Norman Junior H. S., Okla. A brief for and suggestions regarding the administration of a science club.

Michael J. Kenny, Joseph Jenks Junior H. S., Pawtucket, R. I. Student projects and exhibits to motivate more students toward science.

Mrs. J. R. Kershner, Fairview Elementary School, Dayton, Ohio. A brief for various activities for enriching science classrooms ranging all the way from use of the Stansi-Science Kit through bringing Captain Video and Tom Corbitt into the classroom.

Edward L. Kessler, Patterson Park H. S., Baltimore, Md. A home-made, Hertz-optical disc that lends itself very nicely to photography.

Elliott E. Kigner, Thomas Jefferson Junior H. S., Fair Lawn, N. J. Using cooperation with the English department to encourage students to do the background research necessary to get a science project under way.

Thomas H. Knepp, Stroudsburg H. S., Pa. Very practical gardens grown in the classroom using ordinary drinking glasses.

M. Krigelman, Overbrook H. S., Philadelphia, Pa. The development of certain concepts of measurement by using a stick of no particular length as a unit for a new measuring system. Suggestions for exploiting television.

Bernice G. Lamberton, Paul Junior H. S., Washington, D. C. General suggestions for getting science fairs under way.

Lillian Lee, Atlanta Public Schools, Ga. Titles of a series of radio broadcasts, "Your Health."

Mrs. H. B. Lovell, Valley H. S., Ky. A three-dimensional tree of life to show the theory of evolution.

Bessie Lumnitz, Forest Hills H. S., N. Y. Purpose and possible function of the laboratory assistant.

Robert D. MacCurdy, Watertown H. S., Mass. Characteristics of superior students and how they can be handled in an ordinary classroom. Scientific art as another type of classroom activity.

John H. Marean, Reno H. S., Nev. Opportunities to really advertise science, including the new mobile technique.

Geraldine V. Marken, School #234, Baltimore, Md. Converting an old footlocker into a drying-storage cabinet for insect and leaf collections.

Theo Bennet Martin, Grant H. S., Portland, Ore. A motivation scheme involving setting up a classroom with some of the characteristics of an engineering firm.

Louis T. Masson, Riverside H. S., Buffalo, N. Y. A scale having great sensitivity fashioned from such simple materials as a ruler, two old razor blades, and tops of two tin cans.

H. E. Maurer, Bloomington H. S., Ill. An outline-supervised-study method as opposed to the usual daily assignment recitation procedure.

Harry Milgrom, Board of Education, New York City. Realistic and fairly original classroom activities for boys and girls, and suggestions for developing these activities with teachers.

Marcus M. Mitchell, Pullman H. S., Wash. Card game that helps youngsters associate members of the animal kingdom with the proper classification group.

Clifford R. Nelson, Weeks Junior H. S., Newton Centre, Mass. Classroom time for the pursuit of individual topics.

Merlin Nelson, Coeur d'Alene H. S., Idaho. An original test involving the hygiene and physiology of digestion.

Wayne Neustrom, Alburnett Consolidated School, Iowa. A class period set aside every couple of weeks for the sole use of "curiosities" or "unanswered problems."

Margaret K. Noble, District of Columbia Public Schools, Washington, D. C. Plans for a modern helicopter that youngsters can build.

Josephine M. Olson, Washington, D. C. A series of maps and teaching aids to show how bird migration takes place.

Dorothy F. Osburn, Westlake Junior H. S., Oakland, Calif. New types of oral and manual tests carrying such titles as "Double or Nothing", "Two for the Money", and "Take a Number."

S. M. Pattee, Roosevelt H. S., Cedar Rapids, Iowa. A student project involving a booklet "Let's Learn More About the Turtles and Lizards of Eastern Iowa." Includes a linoleum block print for the cover.

Margaret Payne, Walton School, Amboy, Ill. A better job of handling conservation problems, especially soil conservation.

Ray Peach, Kinkaid H. S., Houston, Tex. Getting projects rolling in a science classroom. One idea involves having upper-class students supervise the lower-grade levels.

Marina L. Reby, Hillsborough H. S., Tampa, Fla. Laboratory assistants of varying ranks and responsibilities enable the teacher to give more time for lecturing and vigilance in the classroom.

Carl Reithel, Fort Gratiot Township Unit Schools, North Street, Mich. Using equipment to make grade school science classes more interesting.

Lucile Robson, Ruskin School, Dayton, Ohio. A social science unit.

Hyman Ruchlis, Bushwick H. S., Brooklyn, N. Y. Experiments in psychology involving the chimpanzee to show students some of the psychological aspects of study and other motivation schemes.

Ethel Ruhling, Erie Academy H. S., Pa. A biology lesson transferred to a local sea foods restaurant.

Virginia P. Sanders, Memorial School, Steubenville, Ohio. In order to provide materials to help teach zoology, students were invited to bring various animals into class.

Wallace W. Sawyer, Weston, H. S., Mass. A working arrangement with the industrial arts department enabling science students to gain expert advice and help in the construction phases of their science projects.

Elizabeth A. Semendinger, Belmont Boulevard School, Elmont, N. Y. Enthusiasm radiating from a makeshift science room.

Marc A. Shampo, William Horlick H. S., Racine, Wis: Three ideas: Chemo, a game to teach the symbols of the elements, suggestions for making film strips, and an atomic model board that helps youngsters see the structure of the various atoms.

C. S. Sherwood, Lincoln H. S., Tacoma, Wash. Very clear visual aids for showing the mechanism of solution, the structure of the atom, energy release from fission, energy release upon separation of nuclear components, and a working model of a radioactive nucleus.

Victor M. Showalter, West Carrollton H. S., Ohio. A problem involving the pollution of a stream was used to overcome the letdown that students experience when they come into a chemistry laboratory hoping for opportunities to re[illegible] discover things.

Sister M. Anselmo, S.S.[illegible] onaty Memorial H. S., Los Angeles, Calif. Jingles or limericks [illegible] safety in the laboratory. For example:

"There bloomed a sweet flower called Maizie
Whose lab techniques grew to be hazy,
She read few directions nor heeded corrections,
Now Maizie lies under a daisy."

Sister Jeanne de Florence, A.S.V., Southbridge, Mass. Encouraging students to do special projects by assigning a definite job to each boy and girl for the scholastic year.

Sister Joseph Gabriel, C.S.J., Academia Santa Monica, Santurce, Puerto Rico. A debate, "Do Machines Save Work", as another example of class activity.

Sister Virginia Agnes, Blessed Sacrament H. S., Jamaica Plain, Mass. Finding things in the community and in magazines, in fact everywhere, to help students obtain a functional knowledge of such terms as ratio, proportion, locus, etc.

Margaret E. Small, Butte H. S., Mont. A children's game adapted to a review exercise for science lessons.

C. Richard Snyder, Lansdale Joint H. S., Pa. Student assistants prepare reagent carts to be rolled around the building so as to get maximum use from the available rooms in a very crowded school situation.

Francis St. Lawrence, Lindbergh Junior H. S., Long Beach, Calif. Methods of motivation and perseverance enabling the teacher to exploit the superior abilities of certain selected students by means of student projects.

Sara Sutton, Fulton H. S., Atlanta, Ga. Preliminary draft of a ninth-grade physical science unit on geology.

David F. Sygoda, Bayside H. S., N. Y. Adding value to student laboratory activities by asking them to anticipate results before they carry on a so-called experiment.

Brother I. Theodore, F.S.C., St. Mel H. S., Chicago, Ill. An evolving chart enabling the teacher to keep constantly before his students the symbol and valence of elements and radicals as they are brought up for study throughout the course. Expedites drill.

Daniel S. Thorpe, Washington H. S., Atlanta, Ga. The construction and use of an ergograph.

Lawrence M. Watts, South H. S. Denver, Colo. A science club is set up on the basis of a corporation; includes a sample copy of certificate of corporation.

Simon A. Weissman, Brooklyn Technical H. S., N. Y. An improved falling bodies experiment.

Ruth L. Wilson, Davidson H. S., N. C. Activities for teaching prehistoric forms of life.

Milton G. Wolf, Brooklyn, N. Y. Reference to two articles dealing with the collection of chlorine and the collection of hydrogen sulfide both by the displacement of water.

Gordon Woodward, Old Woodward H. S., Cincinnati, Ohio. Suggestions for increasing student project activities.

Alton Yarian, Emerson Junior H. S., Cleveland, Ohio. An "Animal of the Month" activity.

J. Ross Young, Cambridge H. S., Ill. Card file method of keeping a variety of experiment-demonstration and student activities readily available.

James G. Zobian, Roslyn Public Schools, N. Y. Blueprints for a chemistry room based upon common problems experienced by chemistry teachers; plans designed to overcome eighteen specific problems.

EDITOR'S COLUMN—continued from page 125.

What, then, is our great need? There are many needs. In all fields of the teaching profession there will always be need for improved, more effective ways of reaching our objectives. *Teaching will always be open to criticism for not being as good as it should be.* And foremost among the critics will be the teachers themselves.

But to answer and help straighten out those who criticize school science offerings and enrollments, the great need is for up-to-date, more adequate data. NSTA through its Future Scientists of America Foundation is now engaged in a study to obtain some of this greatly needed information. With the cooperation of the NEA Research Division and the National Association of Secondary School Principals, we are seeking to find out, for example: (a) What per cent of the schools of different size and having grades 11 and/or 12 offer chemistry and/or physics every year, alternate years, or not at all? (b) What per cent of the students in grades 11 and 12 have no opportunity to elect chemistry and physics because these courses are not offered at all in their schools? (c) What per cent of the students in grades 11 and 12 take academic or college preparatory courses and what fraction of these include chemistry and physics in their programs of studies?

The report from the U. S. Office of Education on 1954-55 school science enrollments (March issue of *TST*) suggests that the picture is not nearly as dark as some have claimed. This report indicates that last year, about 483,000 students—*equal to 31.9 per cent of the 11th grade enrollment*—were taking chemistry. Over 300,000 students were taking physics, *a number equal to nearly one-fourth of the 12th grade enrollment.* And the recent report of the National Merit Scholarship Corporation is also encouraging. This report showed that 56 per cent of the boys and 16 per cent of the girls among the 5078 highly talented semi-finalists expressed a desire to become engineers or scientists.

There is indeed a bright side to the coin.

Robert H. Carleton

Science Education 1956 . . .

A DIRECTORY of SUMMER WORKSHOPS and PROGRAMS of STUDY

This directory is included as a professional service to teachers of science in elementary schools, high schools, and colleges, and to institutions listed. The brief descriptions (paid announcements) give the name and location of the institution; the name, title, and address of the person to contact for further information; and special features of the undergraduate and graduate program in science education, and of workshops, special courses, and other offerings scheduled for the summer of 1956. Please mention *The Science Teacher* when you write to any of these institutions. *Editor.*

CALIFORNIA

WEST COAST NATURE SCHOOL, SAN JOSE STATE COLLEGE, San Jose. Gertrude W. Cavins, Director. The school that makes the out-of-doors its classroom will operate four interesting sessions this year: June 10-16, Yosemite National Park; June 17-23, Mammoth Lakes; June 24-30, Lassen National Park; and July 1-7, Asilomar—Monterey Peninsula. Students may register for one, two, three, or four sessions and earn one semester unit for each. Tuition is $15.00 per session. Further information will be sent on request.

CONNECTICUT

WESLEYAN UNIVERSITY, Middletown. Joseph S. Daltry, Director of Teacher Services, Box 3900 Wesleyan Station. A Summer Institute for Science Teachers will feature content courses, special lecturers, seminars, field trips, and demonstration materials. Content courses include astronomy, biology, chemistry, geology, mathematics, physics, and other inter-departmental offerings.

FLORIDA

UNIVERSITY OF FLORIDA, Gainesville. Ned E. Bingham, College of Education. In addition to basic offerings in most of the sciences, the following courses are provided especially for teachers during the coming summer session, June 18-August 11: Undergraduate and graduates—G1 301 *Elementary School Science*, 3 SH; G1 302 *Elementary School Science*, 3 SH; Bly 300 *Common Plants and Animals of Florida*, 3 SH; Bly 301 *Biological Laboratory Technique for Teachers*, 3 SH; Cy 400 *Chemistry for Teachers*, 6 SH. Graduates only —Ede 660 *Science in the Elementary School*, 3 SH; Eds 660 *Science in the Secondary School*, 3 SH.

ILLINOIS

NORTHERN ILLINOIS STATE COLLEGE, DeKalb. Paul E. Harrison, Director of Outdoor Education. Two courses, Ed. 410 and Ed. 411, in Outdoor Education will be offered at the Lorado Taft Field Campus near Oregon, Illinois. These courses are offered for in-service teachers and advanced students in the field of general education and the natural sciences. The program offers experiences in the more effective use of the out-of-doors in the regular instructional program of the public schools; all grade levels are considered. Three semester hours of undergraduate or graduate credit may be earned for each course completed.

THE SCHOOL OF EDUCATION, NORTHWESTERN UNIVERSITY, Evanston. M. Ira Dubins, Assistant Professor of Science Education. Six-week session, June 26-August 4: *Science in the Elementary School;* three quarter-hours credit. Experiments, demonstrations, construction of simple equipment, building a unit, textbooks, free and audio-visual materials, periodicals, field trips, and science content for the elementary school will be emphasized. *Science in the Secondary School;* three quarter-hours credit. Topics include materials, resources, experiments, demonstrations, unit construction, field trips, objectives, and the science curriculum of the secondary school. Three-week session, August 6-25: *Improvement of the Science Curriculum in the Elementary School;* 4½ quarter-hours credit. The course features the development of worthwhile and rich elementary science activities. Registration, June 23 and 25.

MAINE

SCHOOL OF EDUCATION, UNIVERSITY OF MAINE, Orono. Mark R. Shibles, Dean, School of Education. A field course in the natural history of coastal Maine will be offered at Deer Isle prior to the regular summer session. Course will feature direct studies of life environments, giving special emphasis to the plants and animals of marine habitats. The regular Summer Session offerings include varied undergraduate and graduate courses in biology, chemistry, and physics for teachers; also, courses in science education. Any of these offerings taken for graduate credit can be applied toward the M.Ed. degree. All professional study for this degree may be related to science education.

MASSACHUSETTS

BOSTON UNIVERSITY SUMMER TERM, Boston. John G. Read, Professor of Science Education. *Workshop in Elementary School Science (Grades 1-6),* June 25-July 7. Indoor and outdoor science activities will be

demonstrated using the Lilja School, Natick, Mass., and many of its pupils; two or three semester hours of graduate or undergraduate credit may be earned. Registration, June 25. *Teaching of Science in Secondary Schools*, July 9-August 18. A methods course, including lectures, discussions, and reports on problems connected with science instruction in the junior and senior high school. Three credits may be earned; Albert E. Navez, instructor.

SUMMER SCHOOL, HARVARD UNIVERSITY, Cambridge. Fletcher G. Watson, Associate Professor of Education. July 2-August 15. Twenty du Pont fellowships, $400 each, are available to teachers of grades 7-12 enrolling in two courses, *Recent Developments in Physical Science* and *The Teaching of Science*. Eight units credit (graduate) may be earned; courses will emphasize relations of recent scientific advances to basic discoveries and fundamental concepts, and interrelations between contemporary developments in science and technology. Enrollment is not limited to those receiving fellowships. A four-unit course, *Science in the Elementary School*, will also be offered.

NEW JERSEY

RUTGERS UNIVERSITY, THE STATE UNIVERSITY OF NEW JERSEY, New Brunswick. Charles H. Stevens, Director of the Summer Session. Third Annual Rutgers Science Institute, July 5-14, designed for junior and senior high school teachers. Two semester hours of credit may be earned in the Rutgers School of Education. Opportunities will be provided to talk with lecturers who are exploring the frontiers of science, to work with outstanding science educators in study-discussion groups, to participate in laboratory experiences, and to study science in the field. General, physical, and biological sciences will be considered and participants will be encouraged to consider problems of their own schools. A brochure will be sent on request.

NEW YORK

STATE UNIVERSITY OF NEW YORK, COLLEGE FOR TEACHERS, Buffalo. John Urban, Chairman, Science Department. Science Camp, August 12-24, at Allegany State Park for elementary and junior high school teachers. Two semester hours of graduate or undergraduate credit may be earned. Program includes all field work: learning to recognize common plants and animals, studying effects of environment on living things, and elementary geology. Group living in cabins in a beautiful, cool, wooded, mountainous location; excellent food and time for recreation. Total cost for cabin, food, tuition, etc., is about $80.00. Experienced staff of three will conduct the camp which is in its seventh year.

CORNELL UNIVERSITY, Ithaca. Philip G. Johnson, Chairman, Section on Nature, Science and Conservation Education. Shell Merit Fellowship Program, July 2-August 10, available only to invited participants; selections for 1956 have been made. Summer Research participation for six to twelve weeks with flexible dates; some credit may be earned. Summer Session, July 2-August 11, offers many courses in science, mathematics, and other subjects including teaching methods and materials.

NEW YORK UNIVERSITY, New York. C. W. Barnes, Professor of Education. Science Teachers' Workshops, July 3-August 10; Eight points of graduate credit may be earned. Professional scientists and engineers will present their special interests, some in their own laboratories and some in industrial laboratories in the metropolitan area. They will relate their work to present frontiers in their respective fields. Specialists in science teaching will help workshop members interpret these new scientific advancements in planning classroom and laboratory science experiences to serve the developmental needs and interests of young people in this dynamic area of human endeavor. Courses in biology, chemistry, physical science, and elementary science methods are also offered.

OKLAHOMA

UNIVERSITY OF OKLAHOMA, Norman. Horace H. Bliss, Department of Chemistry. Science Department Workshops: June 4-15, Anthropology 290—*Museum and Exhibiting Principles, Materials, and Techniques;* S. F. Borhegyi, C. G. Wilder, and Ralph Shead. June 7-July 19, History 403—*Seminar in History of Science;* D. H. Roller, Jr., Laboratory work in the DeGolyer Collection. June 11-22, Zoology 296—*Materials and Methods of Teaching Animal Biology;* Harriet Harvey. July 9-13, Chemistry 296—*Common Chemicals and Their Handling;* H. H. Bliss. May 28-June 8, Chemistry 296—*Unit Chemical Laboratory Operations;* H. H. Bliss. Graduate credit may be earned in each course. Courses will give maximum opportunity for teachers to work on problems related to science teaching in their own schools; minimum science prerequisites. Registration on first day of each workshop.

PENNSYLVANIA

UNIVERSITY OF PITTSBURGH, Pittsburgh. Vernon C. Lingren, Professor of Education. Science Education Workshop, July 2-August 10. Course is listed as *Special Problems in Science Teaching;* graduate or non-degree students may enroll for four or six credits. Program is designed for experienced elementary and secondary school teachers who desire to work on special problems relative to science teaching in their own schools. Registration, June 28 and 29.

VERMONT

THE UNIVERSITY OF VERMONT, Burlington. L. S. Rowell, Director of Summer Session. Conservation Workshop, July 9-27. Four semester hours of graduate credit may be earned. Lectures, field trips, and visiting specialists in conservation practices are featured. Other offerings include: *Science Methods for Elementary Teachers* and *Science for Teachers*. The former deals with methods of presentation and the latter with the materials used in elementary schools. Fundamental courses in mathematics, botany, chemistry, geology, and zoology.

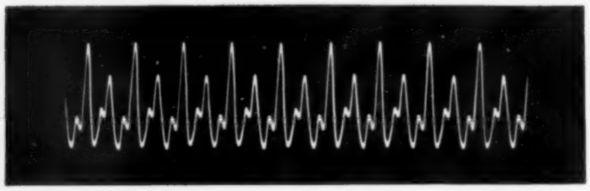
An intrstng exprmnt in spch

Some day your voice may travel by a sort of electronic "shorthand" when you telephone. Bell Laboratories scientists are experimenting with a technique in which a sample is snipped off a speech sound—just enough to identify it—and sent by wire to a receiver which rebuilds the original sound. Thus voices can be sent by means of fewer signals. More voices may economically share the wires.

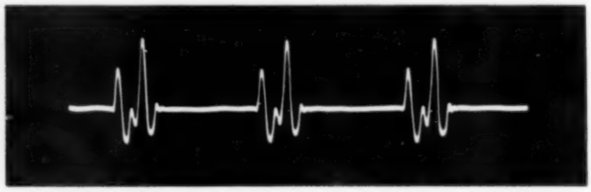
This is but one of many transmission techniques that Laboratories scientists are exploring in their search for ways to make Bell System wire and radio channels serve you more efficiently. It is another example of the Bell Telephone Laboratories research that keeps your telephone the most advanced on earth. *The oscilloscope traces at right show how the shorthand technique works.*

BELL TELEPHONE LABORATORIES

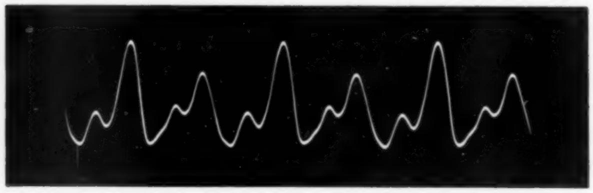
World center of communications research. Largest industrial laboratory in the United States.



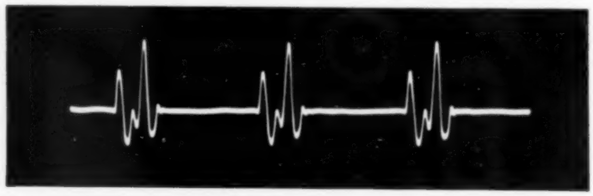
Vibrations of the sound "or" in the word "four." Pattern represents nine of the "pitch periods" which originate in puffs of air from the larynx when a word is spoken.



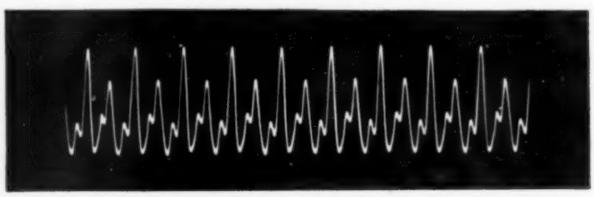
An electronic sampling of the "or" sound. One "pitch period" in three has been selected for transmission. This permits great naturalness when voice is rebuilt. Intelligible speech could be sent through a 1 in 6 sampling.



The selected samples are "stretched" for transmission. They travel in a narrower frequency band than complete sound.



Using the stretched sample as a model, the receiver restores original frequency. In all speech, sounds are intoned much longer than is needed for recognition — even by the human ear. Electronic machines perform recognition far faster than the ear.



The receiver fills in gaps between samples, recreating total original sound. Under new system, three or four voices could travel at once over a pair of wires which now carries only one — and come out clearly at the end!

Classroom Ideas

General

A Different Quiz Procedure*

By ROBERT G. DOTY, Canby Union High School, Canby, Oregon

This procedure is "different" in that the student, while answering the question, is in direct physical contact (or as close as practical) with the object, specimen, or material about which he is being questioned.

A number of "stations" are arranged in the classroom or laboratory. At each station there is a piece of apparatus, a commercial product, or similar exhibit and also a card upon which appears a question pertaining to the item at the station.

Students are provided with an answer sheet, which contains as many blanks as there are stations. At the beginning of the quiz, each student goes to a station and answers the question, using the exhibit material as the reference source.

At the end of a specified time (i.e., 90 sec.) the instructor says "MOVE," and each student proceeds to the next higher station. Those who begin at the last station go to the first station. At the completion of the last move, each student will have visited each station and the quiz is over.

This procedure permits the use of apparatus and actual materials as an integral part of the exercise. The time can be varied to fit the individual situation, and the kind or type of possible exhibits is almost limitless.

The writer has found several advantages to this quiz plan. (1) Students appear to enjoy it as a "break" from the common pencil-and-paper variety; (2) the determination of cause and effect, process involved, etc. is from direct observation rather than from lengthy descriptions (in which semantics may exert a negative influence); (3) comparison of two or more similar items is by direct cross-examination of the items themselves, rather than by the usual lingual route.

The disadvantages, however, are also worthy of consideration. (1) The factor of speed vs. power enters into the interpretation of results; (2) this quiz procedure requires an amount of time which usually exceeds that necessary for a written quiz; (3) classrooms which are used for different subject fields, or by different teachers, etc. may present problems in physical location of the exhibits; and (4) the time necessary for this quiz probably would curtail its use in classes of over 40 pupils.

The writer has used this procedure in both chemistry and biology classes as an occasional form of review. The results have been most satisfactory.

* This idea is not original; it is an adaptation of a procedure that was new to me when used in a course in entomology at Portland State College, Oregon.—*The Author.*

Elementary Science

It's Easier Than You Think!

By PETER BREM, Luther Burbank School, Milwaukee, Wisconsin

The elementary school teacher who wishes to teach some science is often challenged by the need for improvising equipment. This need not be a frustrating problem. In my years of close interest and work with this phase of the elementary curriculum, the great possibilities of simple equipment were again and again brought home to me. To illustrate just one such example, I will enumerate some worthwhile uses of the common, wide-mouth gallon jar.

My source of supply of these jars has been the school cafeteria. Restaurants, too, have them. Pickles, mayonnaise, and probably other food items are packed in them. In laying in a supply of these jars, save the screw top covers. They may be needed in certain instances.

The Siphon—Two jars and a short piece of flexible rubber tubing are fine for an excellent demonstration of the siphon. A gallon jar holds an adequate supply of water to make the experiment of sufficient duration to be interesting and provides enough time for discussion and observation while the demonstration is going on. The changes in water levels are clearly visible. First one and then the other jar can be easily raised to observe the effect.

Fire Needs Oxygen to Burn—The gallon jar can be inverted over a lighted candle. For the sake of comparison a quart jar can be used alongside the

gallon jar, using a lighted candle inside each to note, of course, the difference in time and quantity of oxygen.

Refraction of Light—Fill the jar with water. Note the appearance of a pointer or yardstick inserted when looked at from different angles. Observe appearance of print or fingers placed behind jar. Note what happens to the image of a pencil when the pencil is moved up or down across the water level behind the jar, while looking at the pencil from the other side and through the top of the jar.

Sprouting Seeds—A two-inch layer of peat moss or potting soil in the bottom of the jar makes a fine seed bed. After initial watering, no further attention is usually necessary, since the air inside the jar will be sufficiently humid if the cover is put on. To prevent overheating, the jar should not be placed in direct sunlight.

Starting Cuttings—In a similar way a layer of clean mason or torpedo sand in the bottom of the jar provides a good means for rooting cuttings of common houseplants.

Transpiration of Plants—Placing a wide-mouth gallon jar upside down over a small potted plant will help demonstrate the fact that plants give off water. Droplets of water will form on the inside of the glass wall. For elementary school children this is sufficiently complicated.

A Terrarium—A small and attractive woodland or desert terrarium can be arranged inside a wide-mouth gallon jar. It can almost equal in interest an expensive large terrarium, particularly, since all materials can be gathered free, including the jar.

As an Aquarium—If only one or two small fish, such as native dace or guppies, are kept in the jar with a layer of clean sand and a few water plants, it will serve well as an aquarium for a long time. Should renovation become necessary an extra jar will make this possible in a few minutes. Simply transfer the material from one jar to the other.

An added advantage may be that Mary or Johnny can easily transport the jar home over a vacation period or an extended weekend to care for the pets. This also applies to the care of small pets such as toads or small newts in the terrarium.

A Place for Cocoons—Caterpillars, feeding on leaves inside the jar, can be kept until they are full grown and spin their cocoons on short sticks or twigs. The cocoons can be kept inside the jar, perforated cover on top, until the emergence of the moths.

Ammonia Prints—This is a variation of the blueprint technique. It is a positive process. Reproduction supply houses carry some types of ammonia print paper in convenient sizes. Objects such as leaves can be placed on the paper, exposed to sun-

light, and then the paper, if exposed to ammonia fumes, will bring out positive prints. I have found the wide-mouth gallon jar with tight fitting cover a very suitable device for this purpose. A layer of cotton, saturated with ordinary household ammonia water, at the bottom of the jar does the trick very neatly.

There are many additional uses of this type of jar. One thing that makes it so useful and practical is that the opening is large enough so one can easily reach in and arrange things. And, of course, these jars can be had for the asking.

Physical Science

An Improved Phase Change Demonstration

By WILLIAM R. RILEY, Instructor in Charge of Demonstrations, Department of Physics and Astronomy, The Ohio State University, Columbus

A demonstration frequently used to show the large decrease in volume occurring when H_2O (vapor phase) changes to H_2O (liquid phase) involves the use of a one-gallon can in the shape of a rectangular parallelepiped. The can usually undergoes a gradual crushing as the vapor condenses. The author proposes that a five-gallon cylindrical container of the type in which liquid floor wax is delivered to schools and other community buildings be used in the performance of the demonstration.

The advantages of using the cylindrical can justify the effort expended in obtaining and preparing the can.

1. The demonstration is on a larger scale so that all students are able to see the results.
2. The physical form of the can is such as to give a delayed, sudden collapse instead of the gradual and continuous crushing which is characteristic of the rectangular can commonly used.
3. The apparent failure of the demonstration to work as the students expect it to work is an interest holding device.
4. The sudden crushing effect rather than the gradual one obtained with the rectangular can is dramatic and makes this particular demonstration a good one to use in physical science classes.

Preparation

To prepare for the demonstration rinse the can several times with hot water to remove most of the residual wax. Check to see that the lid makes a tight seal; you may need to scrape the threads with a knife and file the sealing surface of the can lightly to get a tight fit.

In the performance of the demonstration a tripod and burner or a hotplate will be needed to boil the water (200-300 ml.) placed in the can. Allow the steam to discharge for one or two minutes, thus forcing the air molecules out of the can and replacing them with water vapor molecules. Turn out the flame beneath the can and screw the lid on tightly; a pair of leather palm gloves will prevent burns. With the lid tight and the burner removed, pour 300-400 ml. of cold water on the top of the can and then step back. The water vapor in the can then condenses on the underside of the top and drips to the bottom; do not let the dripping sound mislead you into thinking that the good lid which was used is now leaking, for an effort to retighten the lid may cost a hand.

The volume change from the vapor state to the liquid state is of the order of 1800 to 1 so that there is a good partial vacuum in the can. The cylindrical can resists the air pressure uniformly until the difference in the pressure of the vapor inside the can and that of the air outside becomes so great that at some relatively weak spot the can begins to collapse. When it begins, the crushing is almost instantaneous and involves sudden noise and the throwing of the cooling water from the top surface of the can. If it has not crushed after one or two minutes of cooling, a slight tap with a stick on the side of the can will hasten the desired results. *Under no circumstances should the demonstrator or any student touch the walls of one of these cans soon after it fails to perform as one plans.* The forces involved are tremendous and accidents should be avoided at all costs.

The demonstration described is a good one for showing the principles involved in phase changes, for stimulating interest in further study, and for injecting a dramatic moment into a quiet classroom; it is straightforward and safe if the precautionary measures mentioned are taken. It can be used equally well in general science and physical science courses to show one effect of air pressure.

The post-performance discussion might include changes of phase from liquid to solid state and the resulting expansion or contraction that is involved, sublimation of various substances, the processes of expansion, liquefaction, and the heat interchange involved in the operation of a mechanical refrigerator; one might even lead the students in a discussion of the anomalous behavior of water. In this section of heat the terms latent heat of vaporization and latent heat of fusion might also be introduced.

NSTA Activities

Boston NEA Conference

NSTA will have an important role in the NEA's Third Regional Conference on Instruction, to be held at the Hotel Statler, Boston, Massachusetts, April 18-21. The Association and the National Council of Teachers of Mathematics will jointly conduct a major session on "Science and Mathematics Instruction Today," 9:30 a. m. to 12:00 noon on Friday the 20th. Emphasis will be on teaching and learning aids in science and mathematics, effective ways to work with gifted and rapid learners, and how to help motivate larger numbers of capable students into science-related careers. This NEA Instructional Conference, which covers the six New England states, will again be an invitational meeting. Science and mathematics teachers in the region who wish to receive an invitation to attend should write to the Executive Secretary of either NCTM or NSTA, both of which are departments of the NEA.

The Oregon Meeting

The annual summer meeting of NSTA, always held "at or near the place of the meeting of the NEA Delegate Assembly," will this year be held at Oregon State College, Corvallis, July 2-3. The NEA will meet in Portland, July 1-6.

The planning committee is chaired by Dr. Stanley E. Williamson of OSC and is developing a program around the theme, "Arousing Student Interest in Science." Details will be published in the May issue of *TST*. Copies of the final program will be mailed to NSTA members and other science teachers in the seven western states. Copies will also be sent on request to others who are planning to attend the NEA and NSTA meetings, or who simply wish to see the complete program.

The 1956 annual meeting of the NSTA Board of Directors will also be held at Oregon State College, June 30-July 1. NSTA members who can arrive early enough to do so are cordially invited to "sit in" on sessions of the Board meeting.

Other summer attractions offered by Oregon State College this summer include: (a) the 1956 West Coast Summer Conference for Science Teachers, co-sponsored by NSTA's Future Scientists of America Foundation, OSC, and the Crown Zellerbach Foundation (closing date for applications for $200 Fellowships is April 10); (b) the Northwest Regional Institute for Science Teachers, July 9-August 3 (Dr. John S. Richardson, *Ohio State University* and *President-Elect of NSTA*, director); and (c) an Institute for College Teachers of Chemistry, sponsored by the National Science Foundation, July 9-August 3.

Membership Gains

The slope of the NSTA membership curve is still tilted upward at a rather nice angle; "$\Delta y/\Delta x$" for 1955-56 is an encouraging value. As of this writing, we are running a solid 1000 members and subscribers ahead of the *closing date* (May 31) a year ago. The mailing roll for this issue of *TST* fell only a little short of 9,000, even though we unhappily have had to remove some 1200 "dropouts" who held NSTA membership in 1954-55.

"Bargain day in NSTA" begins for all *new* members who enroll after May 1. They will be entered on our books for the balance of 1956 and all of 1957. Urge your friends and colleagues to join; tell them not only what they *get* in return for their membership dues, but stress what they *support* in professional effort. You can still tell them that "every dollar invested in NSTA membership helps unlock $3 from other sources for the support of Association endeavors."

New Publications

Under the guidance of our Publications Committee (Dr. Abraham Raskin, *Chairman*), a new series of NSTA pamphlets on science teaching will soon be launched. First title in the series is *Let's Take a Field Trip*, written by Dr. Paul DeH. Hurd of Stanford University. Other titles are being planned. These pamphlets will sell for 25 cents each or six for one dollar.

Manuscripts for two new titles in the "Science Teaching Today" series are also nearing completion. One of these will deal with "experiences with plants" and the other will provide for "experiences with rocks, minerals, and fossils." Designed for elementary through junior high grades, publication of these new booklets will be announced through *TST* and by direct mail to schools and teachers.

Pre-publication orders at $1.00 per copy are now being accepted for *Science Teaching Through Problem Solving*. After July 1, the price will be $2.00 per copy. This new booklet based on the Fourth National Convention of NSTA, will be published next September. Order forms are being sent to all NSTA members to enable them to take advantage of the special pre-publication price.

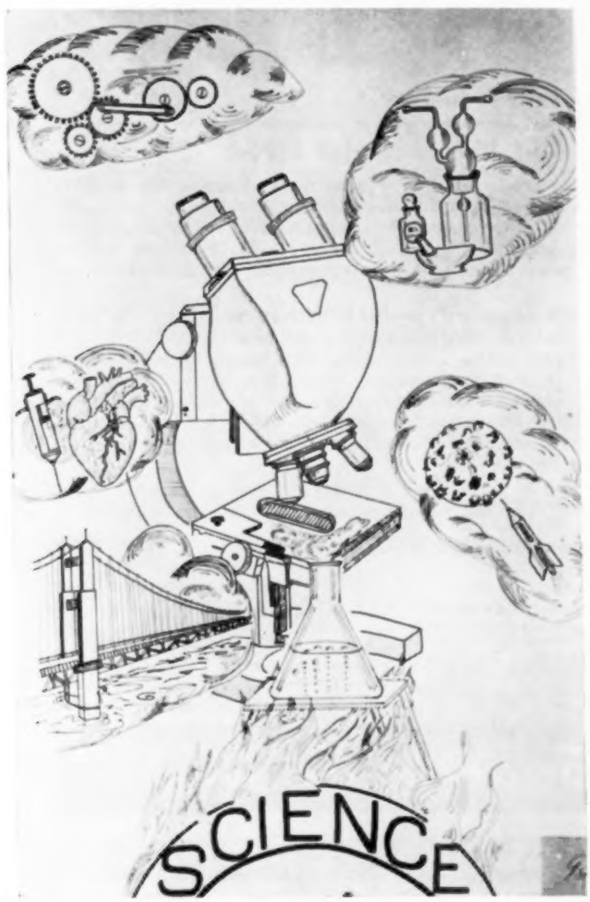
FSA Activities

FSA Chart-Making Contest

"Oh, but that one deals more with technology than with science." "The theme of this one is too narrow." "This one doesn't look at all like it had been copied from a textbook." These are typical of the remarks to be overheard during the judging of the 1956 FSA Chart-Making Contest.

Since this activity has been planned for junior and senior high school people, the judging team of 35 students was chosen from science clubs in Montgomery and Prince Georges, Maryland, counties. Their schools were Hyattsville Junior H. S.; Silver Spring Eastern and Montgomery Hills Junior High Schools; High Point Junior and Senior High Schools; the Academy of Holy Names and Montgomery Blair H. S., Silver Spring; Northwestern H. S., Hyattsville; and Wheaton H. S.

Judging of the 1956 FSA Chart-Making Contest.



A chart designed to show "What scientists do, how they do it, and why their work is important."

It was no easy task to select the 20 best from 360 junior high and the 10 best from 180 senior high entries. An enormous amount of student time was invested in their preparation. Many showed much evidence of carefully given advice from teacher sponsors. We certainly appreciated the careful attention the judges and their teacher sponsors gave to the selection of the winning charts.

May we add one personal note of commendation to all who took part in this activity. The following young people can look forward to receiving $25 worth of science books of their own choosing. The listing includes the student's name, grade in school, and teacher sponsor.

Larry Blum (12th): Bronx H. S. of Science, New York, N. Y.; G. Gewitz

Henry W. Bowman (9th): Roosevelt Jr. H. S., Charleston, W. Va.; Virginia A. Parsons

Florence Dietrich (10th): Northwestern H. S., Hyattsville, Md.; Howard B. Owens

William A. Dunson (9th): Northside H. S., Atlanta, Ga.; Julia Newton

Amy Eng (8th): J. H. S. 60, Bronx, New York; S. Caplan

Robert H. Gaither (12th): Northwestern H. S., Hyattsville, Md.; Howard B. Owens

Norman Galinsky (9th): Roosevelt Jr. H. S., Charleston, W. Va.; Virginia A. Parsons

Gary Greene (8th): Robert Fulton Jr. H. S., Van Nuys, Calif.; S. A. Karlin

Robert Heindel (12th): Central Catholic H. S., Toledo, Ohio; Sister Berenice, O. S. F.

G. Douglas Huth (9th): Brunnerdale Seminary, Canton, Ohio; Rev. Robert M. Palmquist, C. P. P. S.

Roberta Johnson (12th): Windom Sr. H. S., Minn.; Mrs. W. Price

Linda Kasday (7th): Hunter College H. S., New York, N. Y.; Dorothy Edith Ianora

Richard Banks Kaufman (7th): Weeks Jr. H. S., Newton Centre, Mass.; G. E. Anderson, Jr.

Marilyn Kollar (8th): Longfellow Jr. H. S., Yonkers, N. Y.; Ruth B. Schwartz

Dale Kostka (7th): Park Ridge H. S., Ill.; Walter E. Hastings

Dolores Leahy (9th): Aquinas H. S., Chicago, Ill.; Sister John Maureen

Patricia Madigan (9th): Our Lady of Mercy H. S., Rochester, N. Y.; Sister Mary Edwards

George Matto (7th): Fairfield Woods School, Conn.; John J. McGlynn

Barbara Minton (11th): Central H. S., Fountain City, Tenn.; Lula Shipe

Mary Niemeier (11th): Our Lady of Angels H. S., Cincinnati, Ohio; Sister Barbara Ann, O. S. F.

Helen O'Brien (10th): Academy of Notre Dame de Namur, Villanova, Penn.; Sister William Susanah

George W. Palovich (12th): Lorain H. S., Ohio; Harold Freshwater

Maureen Parker (9th): North Plainfield H. S., N. J.; M. Blaustein

Angela Perry (9th): New Bedford H. S., Mass.; Antone F. Felix, Jr.

Suzanne Platt (9th): Our Lady of Mercy H. S., Rochester, N. Y.; Sister Mary Edwards

Gloria Renne and Miriam Salome (9th): Jr. H. S. 60, New York, N. Y.; Johanna M. Kennedy

Edmund Rice (12th): St. Mary H. S., Lancaster, Ohio; Sister M. Amy, O.P.

Charles W. Simpson (9th): Brunnerdale Seminary, Canton, Ohio; Rev. Robert M. Palmquist, C. P. P. S.

Adelino Torres (9th): J. H. S. 52, New York, N. Y.; Morris Berman

Nancy Lee Wolf (9th): Rahway H. S., N. J.; Principal

Tomorrow's Scientists

On the basis of the first issue, over 1000 of tomorrow's scientists have promised to subscribe to their own science journal if the Foundation decides to make it available. Assuming that staff salaries can be paid from other income sources, a minimum of 8000 subscriptions at 50¢ each in groups of 10 or more will cover the cost of printing and mailing eight issues in 1956-57.

We are most anxious to receive suggestions that promise to help *Tomorrow's Scientists* portray the challenges and opportunities which await adequately trained young people.

Book Reviews

THE HUMAN ORGANISM. Russell Myles DeCoursey. 550 pp. $5.75. McGraw-Hill Book Company, Inc., New York. 1955.

This human anatomy and physiology text was designed for use with liberal arts college students. It is also an excellent reference book for the high school biology teacher. Anatomy is kept at a minimum and current research in physiology is given unusually adequate treatment. Latest advances covered in the book include recent work in muscle and nerve physiology, physiology of the blood, Vitamin B_{12} and its effect in the treatment of pernicious anemia, and the Rh blood factor.

RICHARD H. LAPE
Amherst Central High School
Snyder, New York

OPERATION MOON. R. Will Burnett; Consulting editor, Paul F. Brandwein. 48 pp. (Paper covered). Science Research Associates, Inc., Chicago, Ill. 1955.

Operation Moon presents a brief resume of space travel touching on some of the questions as to how, where, speed, type of ship, size, weight, amount of fuel needed, rocket scouts and the like. It tells also of the hazards of space travel. It is easy to read and informative. Although not detailed, it is certainly thought provoking. It is a good booklet to have in the classroom or library to acquaint the students with the possibilities and problems of space travel. Without a doubt, this booklet will stimulate any reader to more serious thought about traveling in space.

ELEANOR L. O. HASLEM
Pequannock Valley School
Pequannock Township, New Jersey

LIFE SCIENCE. Thomas S. Hall and Florence Moog. 502 pp. $6.50. John Wiley and Sons, Inc., New York. 1955.

One of the trends characteristic of curriculum construction in the field of general education for colleges is the movement away from the stereotyped course of study and the adoption of individualized programs better suited to the needs and interests of particular institutions. This is especially true of courses in the sciences.

Because of this trend, textbook writers are finding it increasingly difficult to decide what to include in their books and what treatment to give the selected areas. Those of us who are faced with the task of buying textbooks have an equally difficult chore. Many textbook writers, in attempting to fit their text to too many courses of study, finish with a book which is suitable for very few.

Hall and Moog, in their *Life Science*, a college textbook in general biology, have overcome the serious difficulty described above by their choice of content areas, their methods of emphasis, and their methods of developing the selected areas. The book is divided into the following eleven chapters: The Cell, Life on the Unicellular Level, The Evolution of Plants on the Land, Adaptations of the Invertebrates, The Vertebrates, Mechanisms of Response, Mechanisms of Maintenance, Infection and Immunity, Reproduction, The Origin of Species, and Organism and Environment.

Life Science is written from a phylogenetic point of view with an emphasis on human biology. This approach gives the book a wholeness that is frequently lacking in some textbooks that consist of bound-together, unrelated chapters.

Some of the features of *Life Science* are the following:

1. The book is set in two sizes of type. The sections in larger type form a semi-independent body of materials. The sections in smaller type are generally more technical. This allows for a great amount of variation in the way the textbook can be used.

2. The book contains many extremely fine drawings, diagrams, and photographs. Those diagrams illustrating progressive steps in a process are particularly outstanding.

3. The authors have succeeded in making *Life Science* more than a compilation of scientific conclusions. The authors stress the methods by which we acquire and test knowledge.

4. The book is up-to-date. The newest findings in the fields of photosynthesis; the chemical mechanisms of growth and energy utilization; and the nature of the gene are all included. The authors supply chemical facts whenever they are needed in a discussion.

5. The bibliographies at the end of each chapter are up-to-date and well-organized. The bibliographies are divided into specific subject matter references, articles of a less technical nature, and valuable books.

This reviewer was well-pleased with Hall and Moog's *Life Science*.

ABRAHAM RASKIN
Hunter College
New York, New York

GENERAL CHEMISTRY. L. E. Steiner and J. A. Campbell. 675 pp. The Macmillan Company, New York. 1955.

This book is in the fine tradition of the work at Oberlin as indicated by the excellent use of historical material throughout it. This reviewer is also in accord with the purposes of a single course as set forth in the Preface and that a course in general chemistry should not be restricted to inorganic.

On examining this text one cannot help but feel the influence Pauling wrought in general chemistry texts. This is particularly notable in the use of illustrations and general organization. One may question, however, the order of some of the chapters in this text. Why, for example, was the chapter on nuclear chemistry placed between the chapters on the halogens and nitrogen when it could have been fitted in earlier more logically? Also the choice in the order of the chapters on metallurgy and metals and the placement of the chapter on qualitative analysis might be questioned.

The text is replete with many excellent diagrams and charts though one may wonder why flowsheets and diagrams were not used with the Frasch process and the manufacture of sulfuric acid.

The difficulties of textbook writers in trying to keep up with recent developments is brought out in the discussion of the diamond synthesis. Could that also be the reason for the omission of literature references?

The above comments, however, do not keep this text from being a very fine addition to the small group of recent texts which emphasize the structural approach to understanding instead of the former largely descriptive.

ANTON POSTL
Oregon College of Education
Monmouth, Oregon

GENERAL PHYSICS. Oswald Blackwood and William Kelly. 704 pp. $6.75. John Wiley & Sons, Inc., New York. 1955 (Second Edition).

Here, at long last, is a general physics text which recognizes the varied interests and vocational objectives of college students in a typical physics class.

This textbook is written in a highly specialized area of science for students who seek thought-provoking problems and exercises in physics which would relate positively and productively to their vocational goals. Unfortunately, the reviewer found stint evidence thereof.

It cannot be denied that this text strongly emphasizes a move toward a student-centered physics text, but it makes a shallow, almost timid, effort to take the "giant step."

The general physics class in the four-year college or the junior college is composed of those students destined to become nurses, home economists, optometrists, dentists, physicians, engineers, chemists, physicists, etc. To these aspirants, physics poses an obtacle because of the traditional methods, materials (especially texts), and objectives which have unwittingly denied recognition to or plans for those areas of applied physics.

The problems, the demonstrations, the overall content of this book are irrationally developed for its asserted objectives, but it does succeed in being an exemplary work of traditional organization and content.

ALFLORENCE CHEATHAM
Hutto High School
Bainbridge, Georgia

EXPERIMENTS IN THE PRINCIPLES OF SPACE TRAVEL. Franklyn M. Branley. 119 pp. $2.00. Thomas Y. Crowell Company, New York. 1955.

Science teachers have often felt the lack of reliable sources of information which could be recommended to pupils who evince a sound interest in the popular subject of travel in space. In admirably filling this need, Frank Branley debunks some misconceptions and exaggerated notions which secondary school pupils often accept blindly as a result of contact with comic books and television. He then lays a solid foundation for critical thinking about the manifold difficulties which confront present rocket scientists and future astronauts.

The reader is encouraged to attempt simple experiments using readily-available materials in order to appreciate the problems and their possible solutions.

The book is replete with excellent line drawings and revealing tables which explain the relationships of distances

and forces among the bodies of our solar system. Repeated emphasis is laid upon the necessity of careful observation, thorough planning, and adherence to sound principles based upon natural law in order that man may be able to survive and navigate in space.

MARTIN L. STAPLETON
State Teachers College
Kutztown, Pennsylvania

MAMMALS, A GOLDEN NATURE GUIDE. Herbert S. Zim and Donald H. Offmeister. Illustrated by James Gordon Irving. Unpaged. $1.00 (paperbound), $1.95 (clothbound). Simon and Schuster, New York. 1955.

This easy-to-use guide pictures in color 218 different mammals in the habitats where one would expect to find them. Included also is a small map of the United States which shows their distribution at a glance. By means of a brief pictured key you can quickly associate any particular mammal with the family or group to which it belongs. Then by turning to the pages indicated, you can identify it as to a particular species and find an astonishing amount of information regarding it. Though common names are used, one can find the scientific name by turning to the end of the book. A bibliography is included. This is a book that both children and adults will find useful.

NED E. BINGHAM
University of Florida
Gainesville, Florida

THINGS AROUND THE HOUSE. Herbert S. Zim. Illustrated by Raymond Perlman. 32 pp. $1.75. William Morrow and Company, New York. 1954.

Through explanations and colored diagrams, the everyday things within the home: doorbell, electric bulb, furnace, and refrigerator are interpreted for the young reader. These conveniences which are important for our health and comfort but are taken for granted in our daily living, are carefully explained on a level that would be easily understood by children. Typical of the recent books by the same author, there are alternate pages of small and large type. Teachers will find the labelled diagrams interesting, distinct, and self-explanatory.

MURIEL BEUSCHLEIN
Parker Elementary School
Chicago, Illinois

YOUR CAREER IN PHYSICS. Philip Pollack. 127 pp. $2.75. E. P. Dutton & Co., Inc., New York. 1955.

Many young people are realizing the important part that physics plays in our world of today and are thinking seriously of some phase as a life work. Philip Pollack writes of these varied phases of physics and gives interesting example of problems and discoveries in each field.

One feature of the book which will be helpful to the student who is considering the physics field is the listing of some of the educational institutions offering courses in various areas. Average salaries or range of salaries are given with references. Photographs are used to illustrate several of the main fields.

A short history of the beginnings of physics given in the first chapter is followed by the qualifications to become a physicist.

CHARLES WILLIAM ALBER
Blaine Junior High School
Muncie, Indiana

ELECTRONICS FOR YOUNG PEOPLE. Jeanne Bendick. 189 pp. $2.75. Whittlesey House, McGraw-Hill Book Company, Inc., New York. 1955.

A clever, precise, factual treatment of electronics. Suitable for children of about age twelve and up—and for adults who desire a simple, but thorough understanding of the entire field. The author has shown remarkable restraint in sticking to the basic details and omitting more complex and historical material. The technical points are profusely illustrated by extremely clever drawings done by the author.

KENNETH V. JACKMAN
Hill School
Pottstown, Pennsylvania

CHICKENS AND HOW TO RAISE THEM. Louis Darling. 63 pp. $2.00. William Morrow and Company, Inc., New York. 1955.

This book will be of interest to children who want to know how to build inexpensive poultry houses, brooders, and feeding equipment, and how to raise chickens. It will also be invaluable to children who want to know about the selective breeding of domesticated animals. Other topics discussed are how eggs are fertilized, how embryos develop, and why animal actions should be judged on a different basis from humans.

JUNE E. LEWIS
State University
Plattsburgh, New York

GREENHEAD. Louis Darling. 95 pp. $3.00. William Morrow and Company, Inc., New York. 1954.

Ahead of oncoming winter, Greenhead, a mallard duck, wends his way in majestic flight from northern Canada to the bayous of Louisiana—there to rest and feed until he may return in the spring to his breeding grounds. Writing in perspicuous style, the author relates the life cycle of the mallard, and to some extent waterfowl in general. The specialized structures which enable the mallard to fly, to obtain and digest food, and to see, are described in minute detail by use of diagrams and words. Bird banding is presented as a valuable means of studying bird migration and through it the four main paths of migration flyways are discovered. Considerable attention is given to the problem of conservation. The book is profusely illustrated with vivid, action pencil drawings.

JAMES SHORT
South Olive School
West Palm Beach, Florida

Audio-Visual REVIEWS

MOLLUSKS. 14 min. sound, 1955. $62.50 B & W, $125 Color. Encyclopedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: Because of the content and vocabulary this film is best suited to senior high school biology, or in introductory college work. Teachers' manual is provided with the film.

Content: This film is another of the films on marine life. It describes the forms, functions, and habitat of the several classes of mollusks. The film brings forth the economic value of these shelled animals, both as a source of food and as precious stones. The photography of these specimens in their natural habitat is excellent.

Evaluation: The content and photography of the film are good. It, also, has excellent instructional quality.

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LIFE STORY OF A WATERMOLD. 12 min. sound, 1953. $55 B & W. Phase Films, Arthur Brice, P. O. Box 423, Ross, Calif.

Recommendation: Suitable for advanced classes in high school biology and college botany.

Content: A study of a water mold, *Allomyces,* revealing the basic biological phenomena of growth and reproduction. Shows the cyclic alternation between diploid sporophytic and haploid gametophytic generations. It emphasizes the precision of the hereditary mechanism of the cell, and stresses the plant's high degree of complexity and differentiation.

Evaluation: The commentary was very technical in nature, and it was felt that the film could be understood only by very superior high school students. The voice of the commentator was not pleasant. The phase-contrast method of photography was used and the scenes for showing the various processes were remarkable. The film was a great advance over the many tiresome diagrams used in other presentations. A teachers' guide is included.

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PLANT GROWTH AND MUTATION IN SPIDERWORT. 11 min. sound, 1952. $55 B & W. Phase Films, Arthur Brice, P. O. Box 423, Ross, Calif.

Recommendation: Suitable for advanced classes in high school biology and college botany.

Content: Employs time-lapse photography through the phase-contrast microscope to show the four stages of cell division in the stamen filaments of the spiderwort. It clearly illustrates the splitting of chromosomes and the doubling of chromosomes. The use of a colchicine solution is shown to prevent the last two stages of cell growth from taking place. The film actually shows the student the nucleolus in the nucleus, and the movement and migration of the chromosomes.

Evaluation: This method of photography is excellent for recording the stages of mitosis. There were some rather lengthy periods without commentary which would make the film unsuitable for high school students. The commentary when given was excellent, but material covered was of a very technical nature. Teachers' guide included.

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FRONTIERS OF SCIENCE. 17 min. B & W, 1954. Rental film from Audio-Visual Center, University of Oklahoma, Norman, Okla.

Recommendation: Not suitable for the average high school class. Might be used with some effect among groups of science teachers.

Content: Shows exhibits made by junior and senior high school students at the Science Fair held at the University of Oklahoma in 1954. Students and teachers are interviewed to obtain their source of interest. Views of a number of the exhibits are shown.

Evaluation: The film was prepared for a local TV program and may not be suitable for other areas of the country. It was sponsored by the Southwestern Bell Telephone Company as a public service and is designed to boost the idea of a regional or state-wide science fair. The photography was quite poor in many spots due to faulty lighting, and the sound faded considerably so that it was impossible to hear the commentator. However, due to the lack of films in this area it might be used to sell the idea of the science fair.

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BALANCE AMONG LIVING THINGS. 45-frame filmstrip, 1950 $6.50 B & W. Popular Science, 353 Fourth Ave., New York 10, N. Y.

Recommendation: May be used as topic guide in intermediate grades and junior high school.

Contents: The film emphasizes the interdependence of animal and plant life in a land environment to all children, schoolyards, parks, or sidewalks. Children can learn these relationships within the environment of the community.

Evaluation: Photography is good but content is not too well organized. Distribution maps of snakes were questioned as to accuracy. Print was hard to read in some places. Teachers' guide included.

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BLIND AS A BAT. 7 min. sound, 1953. $30 B & W, $60 Color. Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles 25, Calif.

Recommendation: Suitable for upper elementary, junior high, and senior high school levels in general science and biology.

Content: The bat is shown to be a useful insect killer, as well as the only mammal that flies. Close-ups show that the bat has well-developed eyes. The ability of the bat to fly safely in the total darkness of caves is demonstrated by controlled experiments in the laboratory. Bats are captured and taken to the laboratory for study. The inaudible

cries, uttered as a type of "radar", are heard by means of special equipment. Then a laboratory obstacle course is set up. With its eyes blindfolded the bat shows remarkable ability to avoid obstacles, but when the mouth is tied shut, this ability is lost.

Evaluation: The film is well done and the sound is good. Close-ups of the animals will be interesting to children. The slow-motion record of the bats avoiding the obstacles in the laboratory experiment is a fascinating bit of photopography. The color adds much to the film. A teachers' guide is included.

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GAS LAWS AND THEIR APPLICATION. 13 min. sound, 1954. $62.50 B & W. Encyclopedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: The film is best adapted to senior high school chemistry and physics. A good introductory film for college physics or engineering fields also. A teacher's manual accompanies the film.

Content: This film demonstrates some of the early research which led to the discovery of the relationships between the temperature, volume, and pressure of gases. It shows the apparent reaction of various gases and how they are affected by changes in temperature, other conditions remaining constant. The applications of the gas laws are shown in compression, refrigeration, heat engines, and low temperature research.

Evaluation: The photography and commentary were excellent. The animation to show molecular motion adds clarity to the concepts developed.

ATOM AND THE WEATHER. 12 min. sound, 1955. $55 B & W. Handel Film Corporation, 6926 Melrose Ave., Hollywood 38, Calif.

Recommendation: Junior and senior high school science area.

Content: The film shows the effect of atomic radiation on weather conditions. The "fall out" of particles was shown to have little influence on the weather.

Evaluation: Photography and commentary were fair. This film is one of a series being produced through the technical assistance of the Atomic Energy Commission. A good film for use within the specified areas.

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WEATHER. Three 50-frame filmstrip series. $6.50 B & W for each strip. Popular Science, 353 Fourth Ave., New York 10, N. Y.

Recommendation: Intermediate and junior high school.

Content: These filmstrips describe the fundamental or basic reasons for weather such as the changes in climate and weather conditions, the season changes, and the relationship between these changes and our weather conditions. The titles are: "We Learn About the Weather," "Understanding the Weather," and "Changes in the Weather."

Evaluation: Generally good as to content and organization. Printed captions are fair in some portions. The filmstrips are designed to accompany the *How and Why* science books.

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